AD-A080 758 INTERAGENCY COMMITTEE FOR SEARCH AND RESCUE WASHINGTON DC F/G 17/2.1
EMERGENCY RESPONSE COMMUNICATIONS PROGRAM.(U)
JUN 79

UNCLASSIFIED NL

1 OF 2
AD A
080758

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
U.S. COAST GUARD (G-OSR-4)
WASHINGTON, D.C 20590
PHONE 202-426-1933

Jan 21, 1980

5600

Defense Technical Information Center
Cameron Station
Alexandria, VA 22314

Attn: DTIC/DDA

The following report is submitted for inclusion on your listing. Distibution on both sections is unlimited.

6 "Emergency Response Communications Program"

~~"Federal and State Responses to the Emergency Response Communications Program. Draft Report, March 1979"~~

Both sections of the report were completed by an ad hoc working group of the Interagency Committee on Search and Rescue (ICSAR).

D. H. LUZIUS
By direction

11 Jun 79

file

EXECUTIVE SUMMARY

The Interagency Committee on Search and Rescue chartered an ad hoc working group, at the request of the Department of Defense, to examine emergency communications requirements and to assess the ability of existing communications systems to meet these requirements. The working group rapidly concluded that, under emergency conditions, existing communication systems exhibited significant deficiencies in coverage and were operationally vulnerable to the emergency condition itself. One of the first steps the working group took after reaching this conclusion was to meet with the Office of Telecommunications Policy to present a revised charter which addressed Federal, state, and local problems to the Executive Office of the President for approval. The basic problem identified in this early stage of the study was that below the level of a Presidentially declared emergency there was literally no organized approach to handle an emergency situation. The Department of Defense, as executive agency for coordinating inland search and rescue, was aware of this in that the Air Force Rescue Coordinating Center has 48 separate and distinct memoranda of understanding -- one for each state -- concerning the coordinating procedures in the states. Armed with this information, the working group proceeded to meet with the states and the Federal agencies involved in rendering assistance in emergency situations.

The working group found that the prospective users could not delineate specific communications requirements but could articulate broad needs -- that is, what they felt was lacking in their present delivery systems. The

working group found that the users themselves recognized their peculiar deficiencies and were in the process of satisfying identifiable needs using state-of-the-art communications systems technology or experimental space technology as available. Many significant advances had been and are being made by the users, yet even the most sophisticated users indicated that there were technical problems of survivability, coverage, compatibility, and recoverability even with the most advanced terrestrial systems. With all the work on terrestrial systems, the working group began to study how space technology might be used. Its feasibility has been demonstrated, but its impact on the user operations is virtually unknown; that is, protocols, benefits, and cost.

This report establishes a need and the salient characteristics for an emergency response communications system. It sets down broad policy and technical requirements of the required system; however, it does not give a detailed cost analysis. The working group met with state, local and Federal agencies with the goal of collecting the users' requirements, and generating a preliminary system design to meet the requirements.

To determine with confidence the cost and benefits of an emergency response communications system, it is necessary to establish a detailed system design based on validated requirements. This is clearly beyond the charter of the ad hoc working group and programmatically premature. Clearly the working group of the committee has established the need for and the characteristics of an emergency response communications system; examined the overall emergency cost of situations to which such a system would respond; and shown that recent government policies and directives provide a mechanism under which this program can be initiated.

One does not have to go far to find examples of needs. Two recent examples are Wichita Falls, Texas, and the Three Mile Island Nuclear Plant accident in Pennsylvania. Tornadoes devastated Wichita Falls, leaving only one telephone channel available to the outside world for communications. Fortunately, the National Association for Search and Rescue and the Air Force are jointly experimenting with a communications relay jeep using NASA's L-band ATS-6. One jeep was airlifted into Wichita Falls and the other into

the state capital at Austin. This additional communications unit expedited relief work and was maintained until conventional communications were restored.

The Three Mile Island Nuclear Plant accident is familiar to all of us. Communications were not available through normal channels. The public communications system became overloaded with people trying to contact their families and friends. The COMSAT CTS portable terminals were alerted but the decision was to use specially dedicated channels from AT&T. There were time delays in decisions and in bringing in the special circuits. This incident shows that, in an emergency, <u>conventional communications can be denied</u>, even if they are not physically destroyed.

This report incorporates portions of a study on a forest fire disaster by ECON, Inc., for NASA. They are included because the study gives events, communications requirements and cost-benefit analysis. The reported forest fire cost $11 million. Timely communications could have reduced the cost by 24%.

The working group conducted four regional meetings with potential users to determine their needs and requirements. In addition to the user's needs, the users articulated for the working group their criteria for an emergency response communications system. The criteria for the system can be summarized as:

- 100% availability
- Compatibility with existing and planned systems
- Selectivity of address
- Privacy of user message
- Immunity from geographical and electrical interference
- Range independence
- Affordable cost.

There have been many advances in communications technology and these advances are being implemented on the local, state, and Federal levels. Some criteria will not be fulfilled even with these advanced systems. For example, Kentucky has one of the best terrestrial emergency communications

systems among the states but indicated that it is extremely interested in a satellite communications system because of lost relay towers during recent severe weather.

Communications systems utilizing space technology were further investigated because they represented a new concept to many users, and they wanted to learn about such systems. Therefore, a preliminary satellite system concept was developed and is presented. There are many studies that must be performed before such a system can be implemented. These studies are not only technical but operational and economic as well. Several of these efforts have been initiated, such as new technology, marketing, economic, and operational studies. In fact, a coalition of DCPA, NTIA, NCS, USCG, DoD, and NASA is undertaking an intermediate interim effort using current inventories to try to formulate and answer some of the unresolved problems.

Finally, the working group has received the National Space Policy, Executive Orders, and White House MOU to implement these orders. Based upon this review it has developed a program management plan for the implementation of an Emergency Response Communications System.

The Emergency Response Communications System, as conceived, will have several roles in emergency communications planning:

- Provide communications to areas in which communications do not exist because conventional systems are nonexistent due to cost
- Provide emergency communications capability in situations where the existing communications capacity has been reduced or destroyed
- Augment existing communications during stress when an overload of existing communications systems occurs.

In the first mode there will be a problem not only in providing the communications services, but also in having the users -- including volunteers, operating independently or as part of loosely organized groups -- employ the communications system efficiently. This will require input/output equipments no more complicated than those of today's telephone or hand-held radios.

In the second mode -- that of providing emergency communications -- the Emergency Response Communications System must be integrated into existing systems so that the user is not aware of the interface. For the Emergency Response Communications System to be truly effective, the user should not know whether his message is carried by normal communications channels or by the system.

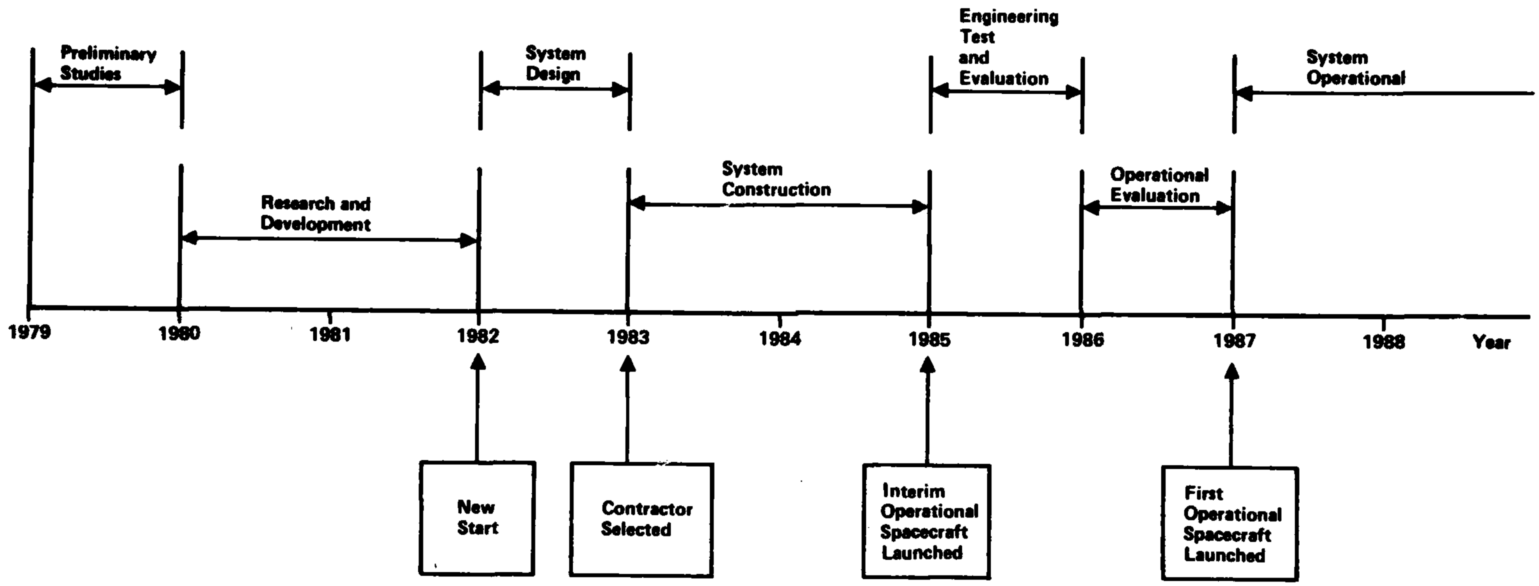
The third mode primarily enhances Federal agencies such as FDAA, FEMA or NCS in their roles in support of a Presidentially declared emergency. This system would be one of the national assets available for use to implement the National Disaster Communications Plan, just as today's private, public, and military systems are available.

This document provides a baseline for developing a politically, economically, and socially feasible emergency response communications system.

With this in mind, the working group recommends that program assignments leading to a National Emergency Response Communications System be made:

- Department of Commerce as executive agent for conceptual and programmatic development
- National Aeronautics and Space Administration for systems research and development
- Federal Emergency Management Agency (considering DCPA amalgamation) as executive agent for operations and maintenance
- Executive Agent for National Communications Systems to explore and implement interim/near-term solutions.

A timeline for this program is shown on the following page.



PROGRAM PLAN TIMELINE

PREFACE

The Interagency Committee on Search and Rescue chartered an ad hoc working group in March 1978 at the request of the Department of Defense to develop an Emergency Response Communications System. With the foreknowledge that the charter was indeed broader than either the responsibility or the authority of the parent committee, the chairman of the working group then presented the charter to the Executive Office of the President, then the Office of Telecommunications Policy (OTP), for approval. This approval in effect sufficiently broadened the charter and actually gave the working group two charters. The Office of Telecommunications Policy has been disestablished and now the authority rests in four separate organizations, as prescribed by Executive Order 12046 and a White House Memorandum of Understanding entitled National Security and Telecommunications Functions. Those organizations/agencies are the Office of Science and Technology Policy, the National Communications System, the National Security Council and the National Telecommunications and Information Agency.

The Emergency Response Communications System must provide national and U.S. territorial coverage as well as integrate and provide service to all public-, disaster-, or safety-oriented governmental agency communications.

The Emergency Response Communications System is:

- Multi-agency - consolidates known emergency communications requirements throughout spectrum of severity

- Interorganizational - responds to Federal, state and local government needs
- Interdisciplinary - incorporates functional needs of search, rescue, emergency medical, pre- and post-disaster, law enforcement.

The Emergency Response Communications System satisfies the emergency communication requirements of all governmental agencies.

The ad hoc working group was tasked to identify user requirements at all levels of severity and government, to consider preliminary systems design to fulfill these requirements, and to establish the appropriate funding profiles for program development. The program envisioned will be a national endeavor to improve the efficiency and capability of emergency communications to all state and local governments and Federal agencies desiring to participate.

The problem of providing and maintaining communications links under all emergency conditions has been articulated by diverse user organizations which range from local law enforcement offices to Federal agencies. These inputs from the user community covered the communications needs of emergencies such as chemical spills, forest fires, natural disaster situations and relief coordination in time of war.

Alternative system concepts based on incremental additions to present equipments, extension of proven terrestrial systems, and employment of satellites have been examined. Many of the user organizations articulated at least part of their need as an addition or modification to existing system configurations.

The system found to best meet national user requirements is based upon the employment of an operational satellite communications system for mobile and fixed station users. A space communication system has an advantage over the terrestrial systems in that it can provide more consistent availability, is independent of distance and terrain, and, with mobile terminals, would be impervious to natural and man-made disasters that would annihilate power and/or fixed structures so that it could operate during and

after disasters. Such a system would be an extension of current inplace systems. The satellite would be equipped with a directional pencil-beam antenna and capable of internal switching.

In addition to improved efficiency and capability in emergency communications, economics were a driving factor in the program development. The program will make maximum use of existing hardware and will promote standard designs for commercial hardware development such as satellite systems, base stations, airborne, mobile and handheld equipment. The final configuration of such a system will be commercially (i.e., private sector) provided and affordable by the user community. By integrating all users, with each user absorbing a small portion of the total cost, the system becomes a financially viable solution for a national emergency response communications system.

This system meets the basic requirements of all all-weather, all-terrain coordinated national mobile communications system, which presently does not exist. The system would be integrated into and extended beyond current terrestrial systems for increased coverage, flexible operation, economy, as well as stand-alone operation when other networks fail.

Reviewing the National Space Policy, White House MOU between the National Security Council, the Office of Science and Technology Policy, and the Executive Agent, National Communications System, and Executive Order 12046, including the acceptability of the Federal Emergency Management Agency as defined in Reorganization Plan No. 3 of 1978. The working group endeavors to satisfy both the Interagency Committee on Search and Rescue and the Executive Office of the President charter with the following recommendations:

* The Secretary of Transportation forwards this report to the President

* The President, with the advice of the National Security Council and Office of Science and Technology Policy:

  -- Appoints the Department of Commerce (NTIA) as Executive Agent for development of the National Emergency Response

Communications Program to include management policy and assurance of frequency allocation

-- Appoints the Federal Emergency Management Agency (FEMA) as lead agency (operating and maintenance agency) for management of the National Emergency Response Communications System

-- Appoints the Executive Agent for the National Communications System as chairman of a working group to explore near-term solutions for the Emergency Response Communications Program requirements.

* In turn, then, the:

- Department of Commerce (NTIA)

  -- Tasks National Aeronautics and Space Administration as research and development agency

  -- Aggregates and chairs a User Steering Group which is composed of systems users from the Federal, state, and local governments

  -- Works with the Federal Communications Commission to assure adequate frequency allocation.

- Federal Emergency Management Agency (FEMA):

  -- Establishes a mechanism for assuming operational management of the program with the advice of the User Steering Group

  -- Coordinates with NASA for applicable technology of the space segment and ground control stations including launch, test, and evaluation of interface with existing systems

  -- Establishes through Government Services Administration (GSA) a contractual mechanism with industry for the development of systems equipment

and provides that mechanism to the users for central procurement

-- In coordination with the User Steering Group and the NCS, formulates systems protocols, systems priorities, operations and maintenance of system control centers.

- Executive Agent for the National Communications System:

-- Works with FEMA and User Steering Group to establish national protocols, priorities, etc.

-- Establishes a working group to explore near-term solutions for the National Emergency Response Communications System requirement and presents those solutions to the appropriate department or agency for implementation.

- User Community:

-- Develops their peculiar systems usage parameters, priorities, etc.

-- Pays a proportionate share of the Operating Fund based on their capacity and usage

-- Purchases the needed ground terminals and interface devices through the GSA-established procurement mechanism.

ACKNOWLEDGMENTS

This report was prepared by
ORI, INC.,
for the

Interagency Committee for Search and Rescue
ad hoc Working Group
Hufnagel Committee

Under Contract NAS5-23438, Modification 96
and Contract NAS 13-126

Funding provided by NASA, NTIA and USCG

ORI, INC.
1400 SPRING STREET
SILVER SPRING, MD. 20910
(301) 588-6180

MEMBERS OF WORKING GROUP THAT CONTRIBUTED SIGNIFICANTLY TO THIS REPORT

RAY HUFNAGEL	DEPT OF DEFENSE AIR FORCE
DON LUZIUS	DEPT OF TRANSPORTATION USCG
JEFF YOUNG	FEDERAL COMM COMMISSION
ARYS HUZINGA	DEPT OF COMMERCE
TONY ANDERSON	NATIONAL PARK SERVICE
FRANK ADAMS	NASAR
ELDON GEORG	AIR FORCE
JOHN WOODRUFF	NASA
LOIS CLARK McCOY	NASAR
JOHN McKINNON	DEPT OF TRANSPORTATION SECRETARIAT
TOM HOLCOMB	DCPA
ROGER REINKE	NTIA

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (Continued)

Figures

LIST OF TABLES

LIST OF ABBREVIATIONS

APCO	Associated Public-Safety Communications Officers, Inc.
ARRS	Aerospace Rescue and Recovery Service
ATS	Advanced Technology Satellite
DCPA	Defense Civil Preparedness Agency
DEA	Drug Enforcement Agency
DOD	Department of Defense
DOT	Department of Transportation
ELT	Emergency Locator Transmitter
EMS	Emergency Medical Service
EOC	Emergency Operation Center
ERCS	Emergency Response Communications System
ERCP	Emergency Response Communications Program
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
GE	General Electric
GSA	Government Services Administration
GSFC	Goddard Space Flight Center
ICSAR	Interagency Committee on Search and Rescue
INS	Immigration and Naturalization Service
LOS	Line-of-Sight
MAST	Military Assistance to Safety Traffic
MOU	Memorandum of Understanding
NASA	National Aeronautics and Space Administration
NASAR	National Association for Search and Rescue
NCS	National Communications System
NSC	National Security Council
NTIA	National Telecommunications and Information Agency
NTSB	National Transportation Safety Board
NWS	National Weather Service
O&M	Operations and Maintenance
OSTP	Office of Science and Technology Policy

LIST OF ABBREVIATIONS (Cont)

OTP	Office of Telecommunications Policy
QRR	Quick Reaction Replacement
R&D	Research and Development
RCC	Rescue Coordination Center
REFSAT	Reference Satellite
SAR	Search and Rescue
SARSAT	Satellite-aided Search and Rescue
SBA	Small Business Administration
SCPC	Single Channel per Carrier
SMSA	Standard Statistical Metropolitan Area
USCG	United States Coast Guard
USDA	United States Department of Agriculture

1.0 INTRODUCTION

1.1 PROBLEM

Response time to an emergency directly affects:

- The extent of casualties
- The extent of property damage, and
- The assessment and relief effort.

Deficiencies have been found in communications facilities used to provide communication services in response to emergencies such as natural or man-made disasters as shown in the table inside the front cover. The providers of emergency response services have repeatedly verified that lack of communications has increased their response time. The effectiveness of reducing response time to save lives has been determined in several studies[1] [2] [3] and even reported before Congress.[4]

---

[1] Study of Alerting and Locating Techniques and Their Impact (SALTTI), DOT USCG, September 1975.

[2] Stephany, S.J., An Evaluation Methodology for Multi-element Emergency Medical Services Systems, NHTSA, IEEE Transactions and Vehicular Technology, Vol. VT-25, No. 4, Nov. 1976.

[3] ICSAR Working Group Report on Satellites for Distress Alerting and Locating, Oct. 1976.

[4] Testimony of Russell L. Schweickart before the Joint Committee on the State's Economy, 4 April 1978.

1.2 OBJECTIVE OF REPORT

The objective of this report is to fulfill the working group's charter by:

- Developing users' requirements/needs
- Showing political feasibility, and
- Demonstrating economic necessity for an Emergency Response Communication Program.

1.3 BACKGROUND

The need for a communication program really started from the recognition of similar communications deficiencies which are experienced by other Federal, state, and local authorities involved in emergency response services. It was found that comparing the coordination problems with the communication problems, the communications deficiencies were really more severe. These communication deficiencies could not be satisfied operationally, technologically nor economically. This deficiency was not only a problem in the Federal Government agencies' communication systems, but was even more apparent at the state and the local government level. Some Federal and state agencies had experimental programs underway with either industry or with NASA using the Applications Technology Satellite Series to demonstrate land mobile satellite technology, which could eventually give rise to the systems architecture to alleviate the communications deficiencies. It was concluded that no single Federal agency, state or local government could financially support the new technology needed, especially the research and development for the required system.

1.3.1 Working Group Charter Expansion

DOD requested the Interagency Committee on Search and Rescue (ICSAR) to charter an ad hoc working group to examine the emergency response communication problem. With the knowledge that the task exceeded the present charter of the ICSAR organization, the working group was chartered to develop an Emergency Response Communications Program (ERCP). The working group was to identify government user requirements. The word "government" was key, because

in the delivery of emergency services, there is another element, e.g., volunteer organizations. Much of the emergency response effort today is provided by volunteers. Emergency response service for the land areas of the United States is fragmented, diverse, and complex, and there is little or no ability to mount a common effort once the emergency escalates beyond the capacity of local assets. Having identified the user requirements, the group was tasked to develop a strawman emergency response system. The chairman of the ad hoc working group, recognizing the scope of the program, presented the concept to the Executive Office of the President, Office of Telecommunications Policy for endorsement. This formal sanction thus broadened the working group's charter, allowing it to work with Federal, state, and local organizations responsible for emergency medical service, law enforcement, and disaster operations, as well as search and rescue operations. The working group was tasked to perform a preliminary funding profile to examine the concept of fiscal operation.

1.3.2 Activities

The implementation of the National Search and Rescue Plan has been the prime responsibility of two government agencies:

- U.S. Air Force, for the coordination of Search and Rescue for all inland areas, and
- U.S. Coast Guard, for the coastal waters, the high seas, and inland waters subject to the jurisdiction of the U.S.

The coordination of inland areas is the responsibility of DOD, with the U.S. Air Force acting as executive agent. Both of these agencies, in order to perform their missions as SAR Coordinators, must work with local officials and other U.S. Government agencies as well as international agencies. Over the past 2 years, the Air Force, with the assistance of the Coast Guard, initiated Executive Seminars for state and Federal officials who have responsibility for Search and Rescue and Safety Operations. Part of this training involves a trip to the Air Force Rescue Coordination Center (RCC) at Scott Air Force Base in Illinois. This RCC coordinates land-based search and rescue missions; is involved with most of the Military Assistance to Safety Traffic (MAST); and provides interagency coordination during disaster operations. Last year, this

RCC alone handled an average of 300-400 daily calls with peaks of 1,100 calls on weekends. It is important to note that this count does not include the majority of land responses to persons in disaster situations. Most of these situations are handled at the local level without the use of Federal Government assets.

The state and Federal executives were given comprehensive briefings on SAR operations and the interfacing of the Air Force and Coast Guard with state and Federal agencies. This seminar approach has led to a significant improvement in rescue operations that require local and interagency cooperation. To continue to improve and further increase the coordination, the Air Force and the Coast Guard are pursuing more information programs on both state and Federal levels covering land and maritime SAR/MAST and boating safety operations.

More important, however, is the fact that the seminars resulted in a better understanding of the problems associated with the coordination of SAR, as well as localized disasters, and other related emergency response situations. When the problems of coordination were eased, the requirement for more adequate communications became a majcr need for all participating agencies. This need has created the necessity for the Emergency Response Communications Program (ERCP).

The working group considered the possibility that the program should include position location requirements. It was concluded that this initial work would be directed only towards the communications problem. Incorporation of the position location would be a Phase II solution.

1.4 GOVERNMENT ACTIVITY CONCERNING EMERGENCY RESPONSE COMMUNICATIONS

The working group has found strong support for emergency response communications at all levels of government, including the President and Congress. This section will discuss and summarize the activity.

1.4.1 Executive Activity

The need for the ERCP is recognized in the basic components of the Presidential Directive on civil space policy.

> "Space activities will be pursued because they can be uniquely or more efficiently accomplished in space... Pluralistic objectives and needs of our society will set the course for future space efforts."

The initial work of the working group indicates that a space solution to the ERCP is unique and may be more efficient than conventional communication systems. The space solution offers more survivability, availability and range. The development of this large user base-low volume system concept also is supported by the second component of the policy statement which states:

> "Our space policy will reflect a balanced strategy of applications. Science and technology development contains essential key elements that will ... assure U.S. scientific and technological leadership for the security and welfare of the nation and to continue R&D necessary to provide the basis for later programmatic decisions."

Industry is not performing significant R&D for this type of service nor is it planning to do so in the immediate future. In testimony in March the president of McDonnell-Douglas told Congress that long-term high-risk R&D needed "seed" money from the government. The Japanese government plans to launch an experimental spacecraft for mobile service which could give them an edge in the world market.

The Department of Commerce's National Telecommunications and Information Administration (NTIA) is charged with the formulation "of policy to assist in market aggregation, technology transfer, and possible development of domestic and international public satellite services. This policy direction is intended to stimulate the aggregation of the public service market and formulate advanced research and development of technology for low-cost service."

While NTIA is responsible for the above, Executive Order 12046 of March 1978 states that:

> "(4-301) The function of coordinating the development of policy, plans, programs, and standards for the mobilization and use of the nation's telecommunications resources in any emergency, which function was assigned to the Director of the Office of Telecommunications Policy ... was transferred to the President. The National Security Council shall assist the President in the performance of this function."

There also exists in the Executive Branch a Memorandum of Understanding (MOU) between the Office of Science and Technology Policy (OSTP), the National Security Council (NSC), and the Executive Agent, National Communications System (NCS). The responsibilities of the MOU are shown below:

<u>OSTP</u>

- Evaluate capability of existing and planned telecommunications systems to meet emergency preparedness requirements.
- Provide policy guidance on requirements to the National Communications System (NCS) of NSC.

<u>NSC</u>

- Coordinate development policy plans, programs, and standards for the mobilization and use of telecommunications resources in any emergency.
- Provide NCS with policy guidance for above.

<u>NCS</u>

- Assure technical interoperability of government telecommunications systems, particularly for national emergency operations.
- Assure telecommunications services to Federal agencies pertinent to the Disaster Relief Act of 1974.
- Assist OSTP to evaluate existing and proposed systems.
- Provide support staff to OSTP for telecommunications resources management.
- Oversee and assure availability of all such emergency resources.
- Provide operational direction of all emergency and disaster telecommunications.
- Develop initiatives and coordination plans, programs, and standards for NSC.

- Develop, coordinate, and maintain a nationwide emergency management structure.
- Conduct training exercises, etc., for agencies that interface during emergencies.
- Develop telecommunications standards.

The proposed Reorganization Plan No. 3 of 1978 (Emergency Preparedness) will have a major impact on national emergency response. The plan is to be effective April 1979 and establishes the Federal Emergency Management Agency (FEMA) and transfers to it the functions of:

- National Fire Prevention and Control Administration (from DOC)
- Federal Insurance Administration (from DHUD)
- Federal Emergency Broadcast System (from Executive Office)
- Defense Civil Preparedness Agency (from DOD)
- Federal Disaster Assistance Administration (from DHUD)
- Presidential authorities now delegated to the Federal Preparedness Agency (from GSA) including National Stockpiling <u>Policy</u>. <u>Disposal</u> remains with GSA.

FEMA will also be given:

- Oversight of Earthquake Hazards Reduction Program
- Coordination of Federal activities to promote dam safety
- Responsibility for assistance to communities in the development of readiness plans for severe weather-related emergencies
- Coordination of national and nuclear disaster warning systems
- Coordination of planning to reduce the consequences of major terrorist incidents.

1.4.2 Legislative Activity

The Congress is currently active in the communications/public service and emergency response areas and has or will introduce several bills. The following are summaries of significant features of the bills:

- Ottinger, Fuqua, and Rose - HR14046, "Public Service Satellite Communications Act of 1978"
  - -- Pursue an experimental program to define, develop, and test a new public service satellite system; and develop and test advanced satellite communications and associated large antenna, multi-beam spacecraft technology for an experimental public service satellite system.
  - -- Establish a Public Service Communications Satellite Research, Development, and Demonstration Program; and establish an office within NASA which, in conjunction with the Secretary of Commerce, shall manage the program, specify rules which detail authority and specific areas of responsibility and develop procedures for specific funding requests. The NASA Administrator shall direct the NASA office.
  - -- Initiate R&D in advanced satellite communications techology and associated large antenna, multi-beam spacecraft technology; and define, develop, and test an experimental public service satellite communications system.
- Van Deerlin/Frey, HR 130515 - Communications Act of 1978
  - -- Revoke Communications Act of 1934 and Communications Act of 1962, but mandate NASA to engage in cooperative satellite communications R&D with ComSat.
  - -- Mandate HEW to "support the development of nonbroadcast telecommunications facilities and services for the transmission, distribution, and delivery of Health, Education, and Public or social service information."

-- Mandate NTA (NTIA) "to demonstrate innovative methods of expanding the availability of public telecommunications services."

-- Change NTIA to NTA with a greatly expanded role.

- Stevenson, "Space Policy Act of 1978" (New version, S 244, introduced in 1979)

  -- U.S. leadership in space science and technology, along with the space shuttle, has produced opportunities for developing and using space structures for various efforts, changing space activities from previous spectaculars to future productive, cost effective, and routine management of Earth-based applications. Continued R&D is required by the government and the private sector. This demands new policy, procedures, and institutional entities.

  -- Initial 10-year goals for applications and science are prescribed in the Act.

  -- A methodology to achieve these goals and to continue the space program is given. Major responsibility is placed on the President, acting directly, and through NASA.

  -- The Act specifically supersedes all others which could otherwise provide appropriations.

- Young Bill[5] - "National Emergency Communications Program"

  -- National system to coordinate local authorities and allow them to go beyond their region in case of a major disaster.

  -- Assist communications planning from the local to the national level.

  -- Promote standard designs for new equipment.

  -- Financed by private industry.

---

[5] From Press Release of 10/6/78.

1.4.3 State and Federal Activity

The state and Federal users have come forth to express their needs. In October 1976 and March 1977, NASA sponsored two workshops for Public Service Communications satellites. At the second conference there were 382 people representing 287 organizations. The Public Safety and Emergency Medical Panels has 30 and 25 people, respectively. The ad hoc working group on ERCP has met with representatives of local and state governments and Federal agencies in four regional meetings in 1978. There is a common thread voiced among all the users concerning the delivery of emergency services. That common thread is:

- Dependence on fixed communications systems and commercial power. In April 1974, tornadoes touched down in 39 Indiana counties causing extensive damage. No communications of any kind were available from many battered communities. Initial communications were established more than 15 hours later by Indiana National Guard mobile units. There were uncoordinated, conflicting reports from amateur radio operators in the area, and factual information was finally obtained at the State Civil Defense Emergency Operations Center by dispatching a state police radio vehicle to the scene. Unfortunately, this report was not received until 10 hours after the town of Monticello, Indiana, had been leveled by the tornado, a significant delay in view of the rescue work to be performed.

- Dependence on weather and geography. On October 9, 1976, an average of 7.5 inches of rain fell on the State of Maryland. However, one isolated cell of the storm dropped an additional two inches on the City of Frederick, causing a normally 8-foot wide, 6-inch deep creek to become a torrent. All telephone service was destroyed, and commercial power was cut. These events reduced radio communications by 90 percent since most systems use telephone lines to their mountain-top remote stations. Assistance was later provided by the State Civil Defense Agency and the state police.

- Lack of coverage or voids — there are voids in present conventional systems (wire and radio). These voids exist even in newly developed Emergency Response Communications systems as evidenced by the State of Kentucky which has one of the best emergency communications systems. Several key relay towers were lost during a tornado.

- Incompatibility of equipment and frequencies. Until recently Air Force rescue units equipped with military communications equipment were not able to communicate with commercially equipped civilian ground rescue units. Now commercial equipment has been installed on the aircraft assigned to this mission. Frequency assignments are a problem in adjacent jurisdictions not only between adjacent states, cities, and counties, but also between the United States and its neighbors.

As concerned users, the Defense Civil Preparedness Agency (DCPA) and the State of California have examined the possibility of using satellites in the role of providing emergency communications. The DCPA prepared an RFP for their service and industry responded. The Director of DCPA decided not to award the contract because industry's solutions, using today's technology, were too costly.[5] The State of California was pursuing a similar path using Syncom IV before proposition 13. One can only conclude that one state or agency will find it difficult to afford an emergency response satellite system dedicated solely to its needs.

1.5 EXPERIMENTAL ACTIVITY

A significant number of the Applications Technology Satellite user experiments are related by their common need for satellite-aided mobile communications. The experiments coordinated by NASA include government and non-government users with many diverse needs and problems that can be addressed with a common communications system. Needs and problems include rural and remote health care delivery; emergency medical service; disaster assessment, operations and relief communications; search and rescue communications and operations; drug,

---

[5] Director, DCPA, letter to governors, 9 February 1979.

immigration and law enforcement; and interstate transportation perils. Communications requirements include two-way voice, one- and two-way data, one- and two-way video. Small, lightweight, inexpensive mobile and portable ground terminals are essential for most of these operations.

All of the experimenters are fully aware of the fact that the ATS 3 and 6 are now operating far beyond their design lifetimes. The experiments will aid in the resolution of numerous technical, economic, and administrative problems related to defining an operational system. There appears to be a large potential need for land mobile satellite communication services, preferably as an integrated extension of terrestrial services. This conclusion is based on reviews of numerous experiments and government and non-government studies.

The potential use of a Land Mobile Satellite System to complement terrestrial networks, particularly for rural or geographically remote areas, can be better understood by referring to Figure 1.1. The 231 shaded areas of the map include those regions, referred to as Standard Metropolitan Statistical Areas (SMSAs) that have a population of 50,000 or more. The SMSAs represent those areas that are most likely to have terrestrial mobile communications (cellular systems) within this century. Two types of advanced cellular systems are nearing completion in the Chicago and Baltimore/Washington areas. AT&T plans to initiate extensive testing of the Chicago system to determine cost factors and other information on which to base future expansion plans. Note, however, even if expansion proceeds rapidly and all 231 SMSAs are provided with cellular systems within 15 years or so, the geographical coverage will still be only about 9 percent of the total land area of the United States. It is precisely in the non-metropolitan areas covering many thousands of square miles where satellites or a satellite/terrestrial system would show promise of being economically superior to an all-terrestrial system.

Table 1.1 is a summary of the major activities relating to land mobile satellite system development. These activities have or will expend $1.8 million by their completion.

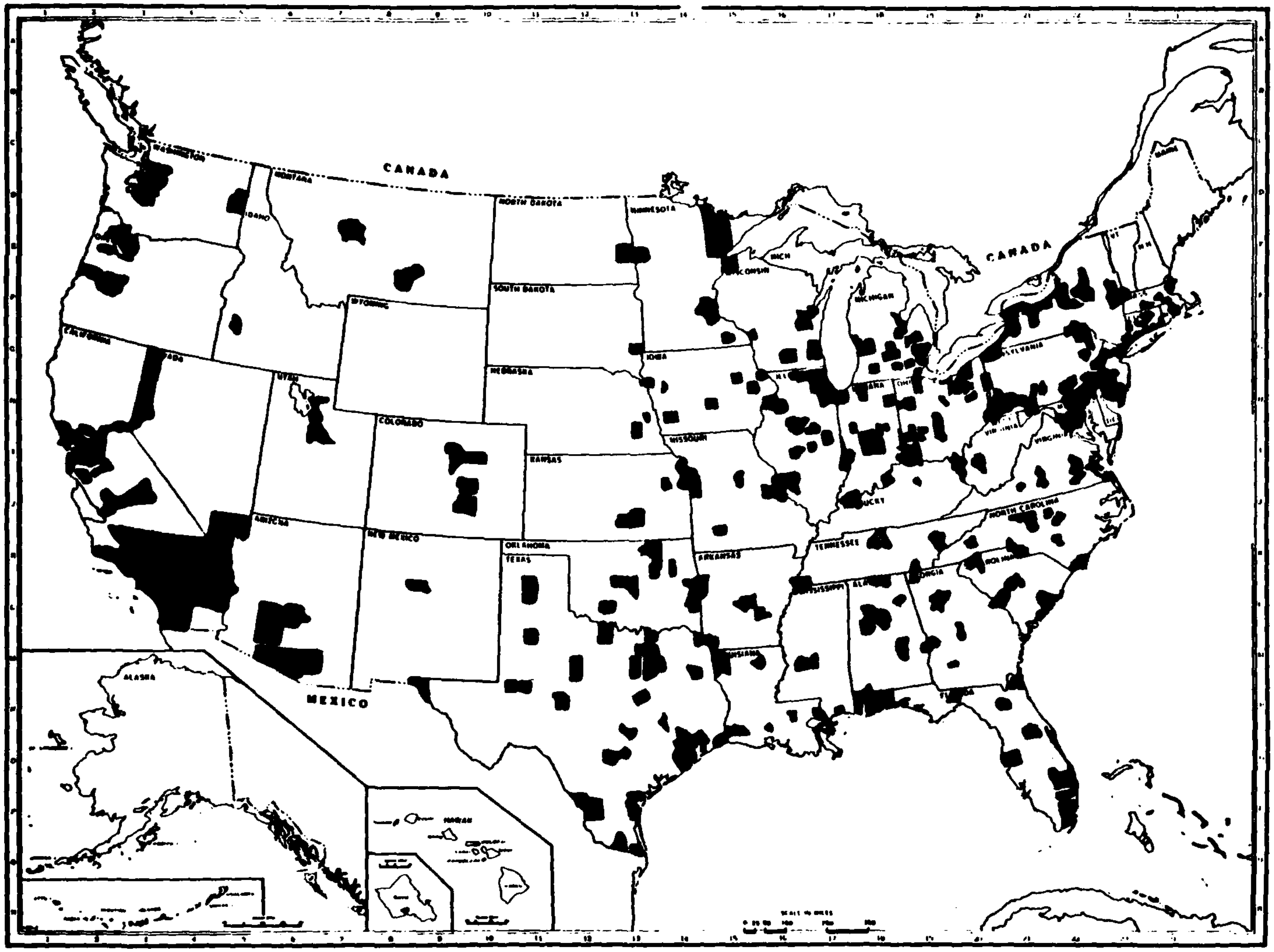


FIGURE 1.1. STANDARD STATISTICAL METROPOLITAN AREAS OF THE UNITED STATES

TABLE 1.1

LAND MOBILE SATELLITE ACTIVITIES

ACTIVITY	ATS	DESCRIPTION	RESPONSIBILITY	STATUS
Communication and Ranging Experiment	1&3	Tracking and communications testing with vehicle base station.	GE/DEA/INS	Completed
EMS Mobile System Development	3	Development of VHF system for transmission of EKG and voice data from moving emergency vehicle.	SRMC NSTL	Completed
Land Portable Briefcase Development	6	Development of a portable self-contained L-Band transceiver.	GSFC	Completed
System Design		Overall system design and analysis of large aperture satellite system capable of serving hundreds of thousands of low-cost mobile/portable terminals. Emphasis upon on-board switching system design and linear PA design.	GSFC	In Progress
System Design	--	Study, design and identify enabling technology applicable to a satellite aided mobile communication system.	General Elec. GSFC	In Progress
UHF and L-Band Propagation	6	Determine ATS-6 fading statistics into a linearily polarizing antenna.	Motorola GSFC	In Progress
VHF Propagation and Fading	6	Develop van test bed to provide data for analysis of 860 MHz propagation - ATS-6.	Westinghouse GSFC	In Progress
Transmitter Development	--	Develop linear, high efficiency EBS power amplifier at L-Band.	Watkins-Johnson GSFC	In Progress
Spacecraft Switching	--	Provide analysis and design of a spacecraft borne mobile communication switching system and support the GSFC mobile study group.	ORI GSFC	In Progress
Position Location		Test a simplified satellite location technique applicable to low cost mobile communication terminals.	GE GSFC	In Progress
Benefits and Marketing		Determine satellite mobile communication benefits for state and federal agencies. Comparison of terrestrial system costs/terminal with satellite concepts. Estimate future markets.	MITRE GSFC	In Progress

TABLE 1.1 (Cont.)

ACTIVITY	ATS	DESCRIPTION	RESPONSIBILITY	STATUS
		Determine satellite mobile communication benefits for EMS, trucking and forestry. Estimate future market and compare costs of satellite concepts with terrestrial systems.	ECON GSFC	In Progress
		Evaluate cost of providing rural communications with cellular and conventional terrestrial mobile communications systems; compare with satellite.	ECO Systems, Inc. GSFC	In Progress
Interstate Trucking Applications	6	Conduct experiment with satellite aided communications in routine operations for trucking company.	GE GSFC	In Progress
Emergency Medical Services Applications	3	Implementation, operation and evaluation of an experimental satellite aided EMS communication system for application in the rural health care setting.	SRMC NSTL-Hopkins	In Progress
State Government Applications	3	Experimental testing of satellite communication for use by State government in conduct of duties involving hazard crisis situations.	State of Calif. ARC	In Progress
Emergency Response Search and Rescue	6	Test and evaluation of experimental portable satellite communication systems for land based search and rescue operations.	NASAR/DOD	In Progress
Immigration and Naturalization Services Applications	3 or 6	Utilization of experimental satellite relay system in supports of INS enforcement and non-enforcement activities.	INS GSFC	Proposed
Emergency Response Communication Applications	3	Conduct experiment of satellite voice and data relay for applications in disaster coordination and search and rescue.	State of Tenn. NSTL/NASA/NPS	Proposed
Fire Fighting Applications	6	Evaluate use of experimental relays to provide responsive communications to a fire scene.	NWS GSFC	Proposed
WARC 1979	-	Frequency sharing studies.	GSFC	In Progress
	-	Conceptualization and integration studies.	GSFC	Proposed

2.0 DEFINITION OF EMERGENCY RESPONSE COMMUNICATIONS

This section contains three parts. This first part describes the general logistics of fighting forest fires and then narrates an excerpt of an actual forest fire scenario reported in NASA's marketing/economic study by ECON. This scenario reflects user needs, requirements, and cost benefit. Equivalent studies must be made on other disaster situations to determine their requirements and benefits.

The second part is an overall view of the size and impact of disasters in the United States to demonstrate for the reader the enormity of the task. Finally, part three is an excerpt from the National Association for Search and Rescue (NASAR) report to show the complexity in collecting the information.

2.1 FOREST FIRE FIGHTING APPLICATIONS[1]

Forest fires occur frequently throughout wide areas of the United States. In 1977 these fires caused an estimated $89 million in damages and burned almost half a million acres. Although fire damage and cost data are alarmingly incomplete, it is known that during 1977 there were over 14,000 fires in the National Forest Protection area alone.[2] Fire suppression activ-

[1] ECON marketing/economic study for NASA - April 1979.

[2] Cumulative Forest Fire Record for National Forest Protection Area, January 1 through December 31, 1977, supplied by Bernie Erickson, U.S. Forest Service, Rosslyn, Virginia.

ities are becoming increasingly expensive and are estimated to cost on the order of $100 million annually.[3] In recent years, considerable advances have been made in fire fighting techniques. New technologies have been introduced, and modern scientific knowledge as well as operations research techniques are now used. However, the lack of good communications remains one of the major hindrances to effective fire suppression.

Satellite-aided mobile communications may be able to provide a solution to these fire fighting communication problems. In the ECON study, a major application of mobile, satellite-aided communications to forest fire fighting is presented.

2.1.1 Overview of Fire-Fighting Agencies

This section provides background material on the extent and ownership of U.S. forest land, as well as on the agencies involved in fire suppression. Such information is necessary in order to gain an overall picture of the organization of fire fighting activities in the United States.

In the United States, there are about 1.5 billion acres of land protected against fire hazard. About 48 percent of this land belongs to the Federal Government; the remaining 52 percent is state or private land. Unfortunately, no more detailed breakdown of the ownership of protected land is available. The Federal Government owns about 21 percent of the U.S. commercial timberland (the Forest Service, 18 percent; other Federal agencies, 3 percent). State and locally owned land accounts for another 6 percent. The bulk of commercial timberland is owned by the private sector (73 percent), while the remainder is owned by state, county, or municipal governments.

The division of responsibility among the various agencies is fairly simple. Most states give responsibility for protecting state and private lands within their boundaries to their state department of forestry. Federal agencies are responsible for fighting fires on Federal lands. In the case of large fires (1,000 acres or more), the state fire-fighting resources are often not adequate, and the U.S. Forest Service provides assistance in men and materials. In addition, if a pocket of state land lies within a larger area of

---

[3] Crosby, J., "A Guide to the Appraisal of Wildlife Damages, Benefits, and Resource Values Protected," USDA Forest Service, RP No. NC-142, 1975.

Federal land, the Federal agency will usually be responsible for fire protection on the state land and vice versa. The most important Federal agencies involved in fire suppression are the United States Forest Service (USFS), the Bureau of Land Management (BLM), the Bureau of Indian Affairs (BIA), and the National Park Service. The largest of these agencies is the Forest Service, which administers the national forests throughout the country and has primary responsibility for protecting national forest land. It also enters into agreements with other Federal and state agencies to protect land outside of the national forests. The Forest Service is organized into ten regions, each of which is responsible for a particular area of the United States (see Table 2.1 and Figure 2.1).

2.1.2 Present-Day Fire Suppression and Communications

An overview of present-day fire fighting strategy, with an emphasis on communications requirements and present-day communications capacity, is presented in this section.

When a fire is discovered on national forest land, that forest's fire team is immediately sent to the fire. During this period of initial attack on the fire, the team uses the regular forest communications network. This is usually a system consisting of one or two radio channels that are used in the daily operations of forest personnel.

Since fighting a large fire usually involves a tight organization and a large number of men and supplies, good communication is essential if the suppression efforts are to be effective. In order to understand the communication needs for a large fire, it is necessary to have some understanding of the large fire fighting organization. Most large fires are fought in a manner similar to the three-division fire to be described.

In a three-division fire, the fire fighting efforts are coordinated by the fire boss and his deputy, the line boss, operating out of a fire camp located approximately 1/4 mile from the fire line, as shown in Figure 2.2. Also, as shown in Figure 2.2., the fire line is sectioned into three divisions (A, B and C), each representing between 150 and 200 men directed by a division boss. In addition to this ground network, there is an air organization for each fire, directed by an air boss who is in contact with the fire camp and

TABLE 2.1 DIVISION OF THE U.S. FOREST SERVICE REGIONS

REGION	STATES
1	MONTANA, NORTH DAKOTA
2	WYOMING, SOUTH DAKOTA, COLORADO, NEBRASKA, KANSAS
3	ARIZONA, NEW MEXICO
4	IDAHO, NEVADA, UTAH
5	CALIFORNIA
6	WASHINGTON, OREGON
7	HAWAII
8	OKLAHOMA, TEXAS, ARKANSAS, LOUISIANA, MISSISSIPPI, TENNESSEE, KENTUCKY, ALABAMA, VIRGINIA, NORTH CAROLINA, SOUTH CAROLINA, GEORGIA, FLORIDA
9	MINNESOTA, IOWA, MISSOURI, WISCONSIN, ILLINOIS, MICHIGAN, INDIANA, OHIO, NEW YORK, PENNSYLVANIA, WEST VIRGINIA, MARYLAND, DELAWARE, NEW JERSEY, RHODE ISLAND, CONNECTICUT, MASSACHUSETTS, VERMONT, NEW HAMPSHIRE, MAINE

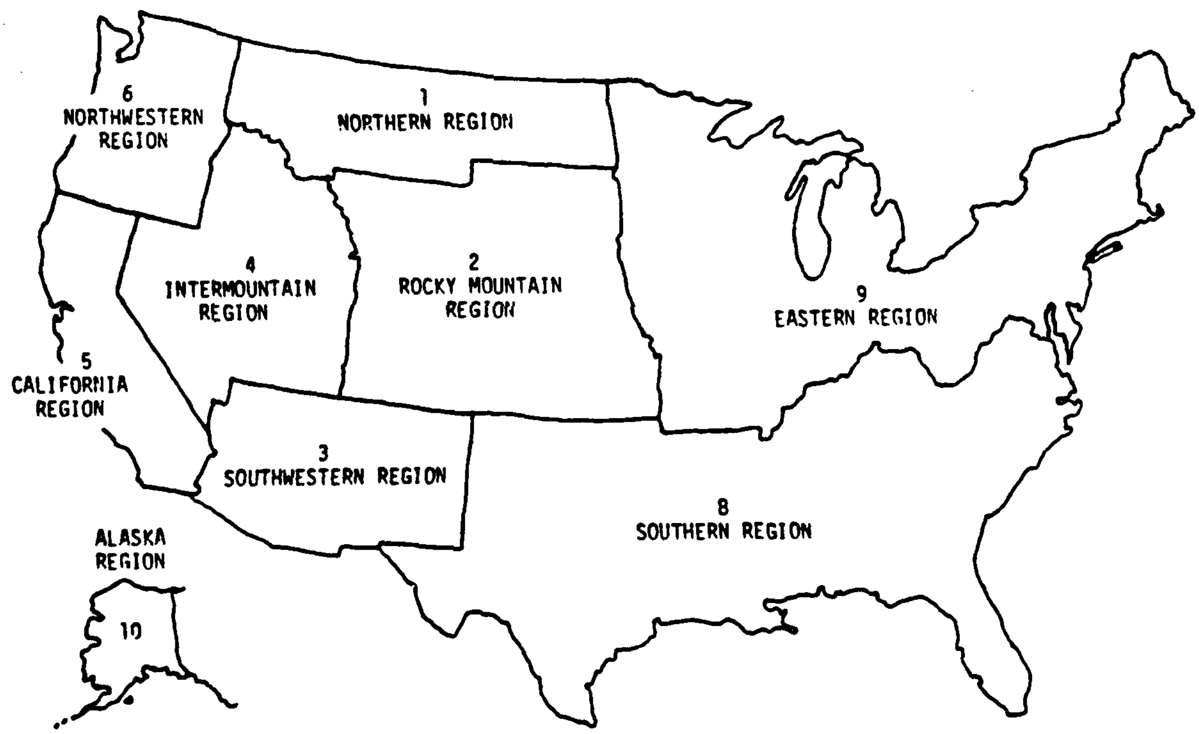


FIGURE 2.1. U.S. FOREST SERVICE REGIONS

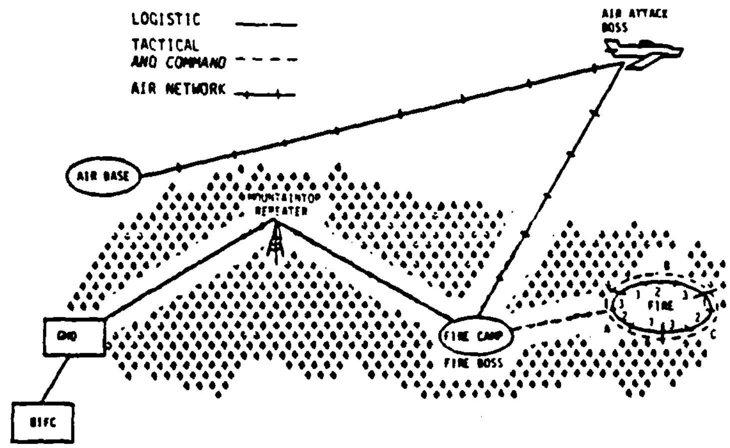


FIGURE 2.2. THREE-DIVISION, TERRESTRIAL, LARGE-FIRE COMMUNICATIONS NETWORK

with an air base from which aircraft used in fighting the fire operate. The fire camp is linked to the general fire headquarters (GHQ in Figure 2.2), which may be located several miles away from the fire, usually in a permanent facility with easy access to phone communications and data processing equipment. The general headquarters often coordinates the fire fighting activities for several fires in the area and is in contact with BIFC and other sources of men and supplies.

A three-division fire uses four separate communications networks: air, command, tactical, and logistics. The air network links the air boss, tankers, helicopters, air base, and fire camp. The tactical network provides communications along the fire line and between the fire line and the fire camp, serving sector bosses, crew bosses, and lower ranking personnel. The command network serves the division and higher ranking bosses along the fire line and in the fire camp. The logistics network is used for the strategic purpose of ordering men and supplies, and for transmitting data to the outside to be processed and used to design an effective fire fighting strategy. The logistics network links the fire camp, the general headquarters, and BIFC. Between BIFC and the general headquarters, telephone communication is used. Telephone links are also installed, whenever possible, between the fire camp and the general headquarters. When this is not possible, radio communication is used. At present, one duplex VHF radio channel serves the logistic need.

Most fire experts agree that present-day logistics communication systems are inadequate to meet the communication needs of large fires, but that available equipment adequately covers the needs of the tactical, command and air networks. The one-channel capacity of present and planned logistics systems is considered insufficient by virtually all experts. The BIFC believes that at least six dedicated circuits (eight in Southern California) are needed to provide adequate communications between the fire camp and the general headquarters.[4] These include: (1) three voice-grade circuits to be shared by the Fire Communications Center, Fire Information Officer, and other work centers in the fire camp, as the particular fire situation dictates; (2) facsimile circuits, one dedicated to Service/Supply, the other to be shared by fire camp work centers, and; (3) one computer-grade circuit to be used for timekeeping, resource coordination, data on weather conditions, etc.

Communications via a satellite-borne radio repeater from a small, transportable earth terminal located in the fire camp to a base station in the general headquarters could greatly facilitate large-fire logistics communication (see Figure 2.3). The satellite system would guarantee the

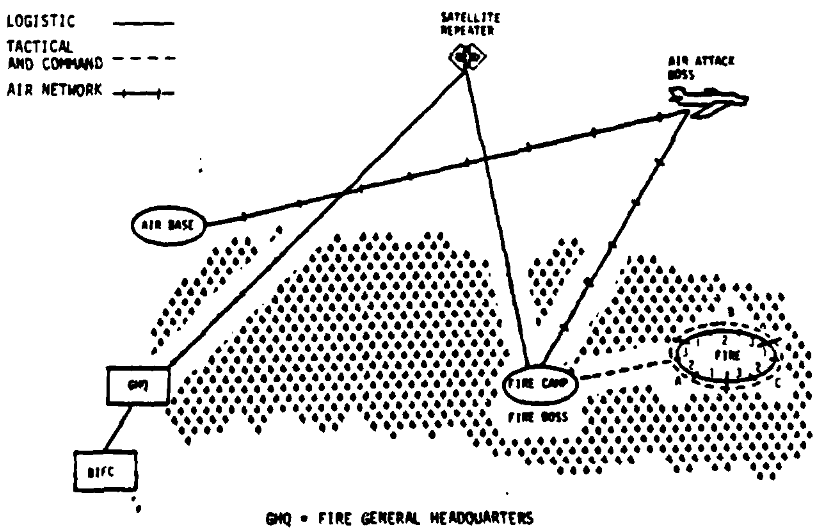


FIGURE 2.3. SATELLITE-AIDED, LARGE-FIRE COMMUNICATIONS NETWORK

[4] Based on an interview with BIFC personnel on July 14, 1978 in Boise, Idaho. Present at the meeting were Don Velasquez, Chief of Fire Communications USFS-BIFC, Les Helms, Electronic Technician USFS, and John Warren, Electronic Engineer USFS.

the vital communications link between the fire camp and the general headquarters during the first few hours of the fire sooner than any terrestrial system presently used. Furthermore, the satellite repeater could provide all six channels required for logistics communications, greatly increasing the usual communications capacity and avoiding the further delays in installing phone lines or microwave systems.

Thus, satellite communications and transportable earth terminals have the potential to overcome the major problems of today's communication systems.

Alternatively, some of the problems of today's communication systems could be overcome by improved terrestrial communications. It is possible to increase the capacity of terrestrial systems sufficiently to avoid problems resulting from inadequate capacity, although it probably would not be possible to decrease the delays in installation. Therefore, the costs and benefits of satellite communications relative to both the existing terrestrial systems and an improved terrestrial system with increased capacity should be examined.

2.1.3 Case Study

The result of the case study is given in this section. After a brief description of the general characteristic of the fire and a description of the communications networks used, the potential benefits from improved communication are shown in terms of timeliness benefits (TB) and capacity benefits (CB).

2.1.4 The Hog Fire

Narrative[5]

The Hog Fire began as 12 separate lightning fires, which eventually burned together. It was discovered by the forest lookout shortly after its origin at 6 p.m. on August 10. Forest personnel from the Salmon River District of the Klamath National Forest began fire suppression efforts immediately, using the regular forest radio network (one voice-grade channel) for both tactical and logistic communications. They also had access to one hot line tele-

---

[5] Based on a meeting with George McCluskey, Chief of Firestaff, Bill Cadola and Joe Bowen, Fire Dispatcher, Klamath National Forest, August 17-18, 1978.

phone and one commercial line located in the Sawyer Bar Ranger Station. Only one of these lines was reliable.

The fire fighting operations continued to build up until the 12th day of the fire, August 22. They continued at that scale for several days, then began to wind down. Demobilization began around September 1 and continued through the middle of the month.

Benefit Areas

The fire experts interviewed did not believe that there would have been significant benefits from satellite-aided communications during the first two days of the Hog Fire. During those two days, the fire suppression organization was simple; there were very few men on the fire, and the existing communications were adequate to meet the logistic need.

It was during the next few days of the fire, before the National Guard mobile microwave system was operational, that benefits from satellite-aided communications (seven duplex-channel capacity, rapid facsimile transmission capability) would have begun to accrue. During these days, a major overordering of men took place, primarily because the logistics communications were poor. The fire boss on the fire ordered a large number of men, but was unaware that it was only possible to obtain these men from Florida, and that it would take several days for them to arrive. The fire experts feel that he would not have asked for the men had he known this at the time, and he would have known this with the earlier logistics communications made possible by the satellite. As a result of this overordering, fire suppression costs were considerably higher than they would have been otherwise. With satellite or other logistic communications during this period, 20 percent of the total expenditure on equipment throughout the fire could have been saved. In addition, money could have been saved through lower expenditures on the support facilities required by the additional men: 10 percent of total supplies and equipment expenditure and 2 to 3 percent of travel expenditure could have been saved.

Finally, even after the National Guard system was in place, certain fire suppresion costs could have been avoided if rapid facsimile transmission had been possible. (This capability would have been compatible with the

12-channel National Guard system, but the proper facsimile equipment was not available at the time and so no hard copy was sent over the system.) Experts believe that in addition to the savings just listed, 10 percent of the total expenditure on the fire could have been saved through the increased efficiency of the logistic operation that facsimile transmission capability would have allowed. This 10 percent savings would have increased to 15 percent during the demobilization period.

In addition to the above savings, the National Guard costs of approximately $5,000 per day for the 19 days the system was in operation, together with several thousand dollars in phone bills associated with the system, could have been saved.

The experts interviewed did not believe that satellite-aided, or any other type of logistics communications, could have resulted in any significant reduction in the number of acres burned by the Hog Fire.

Benefit Calculations

The dollar value of the Hog Fire benefits was computed from the cost information available in the daily large-fire reports. From these reports, it was possible to calculate the expenditures for each day in each of several categories: employment, supplies and equipment (including transportation costs), travel, National Guard and the total. Using the benefit percentages given by the local fire experts for each category and the daily large-fire report information, it was possible to compute total benefits due to satellite-aided communications and also to separate these into timeliness and capacity benefits.

One component of the timeliness benefit was the benefit arising from the overordering that took place during the first few days of the fire. This was calculated as:

20% x employment (except for first 2 days)	$1,551,106
10% x supplies and equipment (except for first 2 days)	229,207
2.5% x travel (except for first 2 days)	6,552
Total benefits attributable if no overordering	$1,786,865

The other component of the timeliness benefit in the Hog Fire was the benefit attributable to increased logistic efficiency during the period before the National Guard system was operational. This was calculated by applying the 10 percent benefit figure to a revised total cost figure for days three through five of the fire. The revised cost figure was what the fire fighting effort would have cost if the overordering had not taken place. The benefits due to efficiency during days three through five were:

10% x revised cost	$41,335.

Thus, total timeliness benefits for the Hog Fire were: $1,828,200. These timeliness benefits are not based upon the use of facsimile devices.

The capacity benefits, based upon the use of facsimile equipment, in the Hog Fire were the 10 percent savings in total cost during the period after the National Guard system was operational and the 15 percent savings during the demobilization period. These percentages were applied to a revised cost figure that showed what the cost would have been without initial overordering. The benefits were:

10% x revised cost (days 6-22)	$762,082
15% x revised cost (days 23-end)	133,839
Total capacity benefits	$895,921.

An additional source of benefits was the potential savings in National Guard costs, which amounted to $72,220.

The total benefits for the Hog Fire were as follows:

Timeliness benefits	$1,828,200
Capacity benefits	895,921
National Guard cost benefits	72,220
Total benefits	$2,796,341.

This amounts to about 24 percent of the total fire suppression costs for the Hog Fire.

2.2 SCOPE OF EMERGENCY RESPONSE COMMUNICATIONS SYSTEM

The ad hoc working group has endeavored to identify user requirements for emergency response communications and to develop broad system configurations which would fulfill these requirements. The working group obtained this broad charter from the Office of Telecommunications Policy when it was realized that no organized approach to handle an emergency situation existed below the level of a Presidentially declared emergency. The ad hoc working group has identified a real deficiency in the communications available during an emergency condition, including no or insufficient capacity, reliance on commercial power sources, and lack of connectivity between responding resources.

The activities covered by the ERCS in this section encompass four major types of emergency occurrences:

1. Disasters (man-made and natural)
2. Emergency medical
3. Law enforcement
4. Search and rescue.

The Emergency Response Communications System (ERCS) therefore aims to provide three major functions:

- Establishing immediate communications to and from areas, groups, and persons affected by an emergency;
- Providing a mechanism to appropriate command and control authorities for a real-time assessment of the emergency's import and status and of the immediate efforts required for its alleviation; and,
- Providing a mechanism for the optimum allocation and control of the required resources from the lowest level emergency to a Presidential Declaration.

The first function is essentially tactical: its object is to provide the necessary communications required to inform and direct responding resources. The second and third functions are basically strategic: the communications system must provide the required connectivity to permit status reporting to the proper responding agency, up to and including the Office of the President of

the United States, for informational purposes, for command and control of the responding resources, and to provide the basis for any discretionary action that is required in meeting the emergency situation.

The acute phase of an emergency situation is specifically addressed by the ERCS, as distinct from routine warning services and from the more conventional services which take place during restoration of the affected area to normality.

The augmentation of existing communications systems when they become saturated or inoperative is specifically addressed by ERCS. In this context, ERCS can provide communications capacity in areas not covered by any existing system. As such, ERCS does not replace, but augments and complements local efforts. ERCS, as treated in this report, covers civilian activities in peacetime and pre-trans-post attack in wartime within the United States.

2.2.1 Economic Considerations

The assessment of the economic value and general characteristics of an Emergency Response Communications system proceeds along the following steps:

- Determination of the impact of the U.S. economy in terms of damage suffered and lives lost and emergency events whose adverse effects can be potentially alleviated by the use of ERCS.
  In commercial terms, this is known as the "gross market" or "market environment."

- Isolation from the environment of the specific potential contribution to ERCS in alleviating physical damage or loss of life.
  This is termed commercially the "addressable market."

- Assessment of the potential user's willingness to pay for ERCS.
  This step of the analysis is required because, even though the value of ERC can be demonstrated, users are not necessarily willing or capable of paying in direct proportion to the benefits.
  In commercial parlance this is the "capturable market."

- Assessment of the most cost effective option, among the potentially available ERCS implementations. This step, known as "competitive analysis," determines which system or mix of systems -- e.g., conventional telephone, ground-based radio relay, satellite relay -- is best suited economically to a large scale national implementation of ERCS.

Conventional procedures of assigning a "value" to human life (typically of order $300,000) appear inappropriate, on the ground of overall credibility.

For example, if the 300 or so extra lives savable yearly by improved emergency response communications are assessed to be worth $90 million, how much more valuable would it be to concentrate these resources to reduce the yearly deaths from heart disease? The fact of the situation is that western society places value upon life, especially upon lives imperiled by unusual circumstances. Thus, efforts to save lives are disproportionately greater than the mere assignment of monetary values would indicate.

A conservative procedure to assess the value of lives saved is to assume that the value to society of life-saving activities is evidenced by the efforts and monies currently spent upon them. Thus, the evaluation of ERCS as a life-saver should be conservatively based on cost-effectiveness arguments: i.e., on the potential savings, over and above current expenditures, achievable from the use of ERCS.

The value of ERCS activities aimed at damage reduction can be legitimately assessed as to the reduced damage which they can foster per dollar invested (benefit-cost) and/or by the reduction of conventional salvage costs possible with ERCS (cost/effectiveness). A conservative estimate of the yearly impact on the economy of the four major types of emergency treated in this report is on the order of $5 billion for property damage only.

This initial report will cover the first step of the methodology, by presenting an overview of the geographic and temporal occurrence, severity, significance of major disastrous events in the U.S., and generalized functional requirements.

2.2.2 ERCS Applications

Table 2.2 lists the major significant applications and end uses for each of the four types of emergency occurrences considered for potential ERCS activities. The end uses listed in the table should be interpreted as applying within the scope of ERCS; for example, the ERCS "warning" function applies only in locales rendered temporarily unavailable or deficient as a result of the emergency event. Additional events susceptible to alleviation by ERCS do exist and are expected to grow with time.

The U.S. public, as a whole, is the ultimate beneficiary of ERCS through the activities of duly constituted Federal, state, and local agencies (ERCS User Agencies). The User Agencies and their major uses of ERCS, corresponding to the areas of activity shown in Table 2.2, are presented in Table 2.3.

It is important to stress that most, if not all, of these User Agencies already possess regular communications channels and networks for monitoring, warning, and real-time command and control. This is exemplified, for the case of natural disasters, in Table 2.4. ERCS can be employed by these Agencies to: 1) replace or supplement lost communications during and after a catastrophic event; and 2) augment the present in-place systems for uncovered areas, as a normal extension of non-existent communications.

2.2.3 Disasters

While the concept of "disaster" is intuitively obvious, its exact definition is not. The Red Cross, for example, defines disaster as "any occurrences affecting more than 10 family units, whether lives are lost or not." The official U.S. definition is "any occurrence which the President designates as disastrous" (aided in his decision by the Office of Emergency Preparedness and by reports from local governors).[7]

Twenty-six major disasters and 13 emergencies were declared by presidential initiative in 1978. Approximately $727 million were spent in direct assistance: $477 million of direct Federal assistance were given to states, local governments, and individuals; $250 million were disbursed in loans to businesses and individual disaster victims.

---

[7] PL93-288.

TABLE 2.2

MAJOR AREA, CLASSES, APPLICATIONS, END USES OF EMERGENCY RESPONSE COMMUNICATIONS CONSIDERED BY THE WORKING GROUP

AREA	CLASS	APPLICATION	END USE
Disasters	Natural	Floods	Flash flood warning Dam burst warning Flood alert special Provision of info. to rescue forces Restoration of comm. in severely impacted areas
		Tropical storms, typhons & hurricanes	Warning of inpending event Event alert Directions to imperiled population Damage assessment Directions to travelers
		Tornadoes	Warning of inpending event Event alert Directions to imperiled population Damage assessment Directions to travelers
		Snow & ice storms	Warning of inpending event Event alert Directions to imperiled population Damage assessment Directions to travelers
		Other Storms	Warning of inpending event Event alert Directions to imperiled population Damage assessment Directions to travelers
		Earthquakes	Alert Provision of info. to rescue forces Provision of directions to civilian population
		Forest fires	Real-time assessment of phenomena apt to strongly affect the situation, e.g. winds, rains, severe storms & torandoes
		Tidal waves, tsunamics searches	Warning of inpending event Alert Report on imperiled persons & damage Provision of info. to rescue forces Provision of directions to civilian population
		Major landslides & mudslides	Warning of inpending event Alert Report on imperiled persons & damage (For SAR, see "Lost Mountain Climbers")
		Volcanic eruptions	Warning of impending event Event alert Directions to imperiled population Damage assessment Directions to travelers
		Avalanches	Warning of impending event Alert Report on imperiled persons & damage (For SAR, see "Lost Mountain Climbers")
	Man Induced	Facility failures-dam collapses, briage failures train derailings	Warning of inpending catastrophe Event alert and location Direction/instructions to population Damage assessment Instructions to travelers
		Nuclear accidents-plant catastrophes, accidental explosions & spills	Warning of inpending catastrophe Event alert and location Direction/instructions to population Damage assessment Instructions to travelers

TABLE 2.2 (Cont.)

Disasters	Man Induced	Other toxic material explosions and spills	Event alert and location Directions/instructions to population Damage assessment Instructions to travelers
		Non-toxic material explosions and spills	Event alert and location Directions/instructions to population Damage assessment Instructions to travelers
		Space vehicle impact	Warning of inpending catastrophe Event alert and location Directions/instructions to population Damage assessment Instructions to travelers
Emergency Medical	Ambulance telemetry in areas & over distances unserved by conventional systems	Acute attacks	Provision of information to Medical Personnel of medical instruction to paramedics
Law Enforcement	Police services (hot pursuit, unforeseen circumstances	Terrorist attacks	Reporting of occurrence & location Provision of C&C service to forces engaged in hot encounter (direction, reinforcements, escape routes, psycho, profiles....)
		Extreme vandalism	Reporting of occurrence & location Provision of C&C service to forces engaged in hot encounter (direction, reinforcements, escape routes, psycho, profiles....)
		Prison riots	Reporting of occurrence & location Provision of C&C service to forces engaged in hot encounter (direction, reinforcements, escape routes, psycho, profiles....)
	Police services (hot pursuit, unforeseen circumstances)	Prison escapes	Reporting of occurrence & location Provision of C&C service to forces engaged in hot encounter (direction, reinforcements, escape routes, psycho, profiles..), tracking of pursuers
		Major civil disturbances	Reporting of occureence & location Provision of C&C service (direction, reinforcements, psychological arguments, controlled use of force...)
	Federal enforcement services (undercovver assignments in precarious circumstances, hot pursuit)	Undercover agent activities (major criminals, illegal drugs, saboteurs, counterespionage...)	Provision of secure communications under precarious conditions
		Clandestine sensors on boats, automobiles, aircraft	Provision of secure communications under precarious conditions
		Nuclear Material theft, hot pursuit Arson (Forest Fires)	Reporting of occurence & location Provision of C&C service (direction, continuity of pursuit...)
Search & Rescue	On land	Stranded or lost vehicles	Rescue of survivors Directions for care of injured Moral support, directions and or assistance to safety Savage of equipment
		Stranded or lost persons	Rescue Directions and or assistance to safety
	On water/ coastal zone	Stranded or lost vehicles	Rescue of survivors Directions for care of injured Moral support, directions and or assistance to safety Savage of equipment
		Stranded or lost persons	Rescue Directions and or assistance to safety

TABLE 2.3

PRINCIPAL USER AGENCIES OF EMERGENCY RESPONSE COMMUNICATIONS AND MOST SIGNIFICANT USES

USER AGENCY	MAJOR USE
Department of Defense Defense Advisory Committee on Federal Aviation	- National search and rescue coordination - Federal air space management - Commercial air service regulation
Federal Emergency Management Agency	- Statutory requirement to provide emergency communications for any type of emergency, including tie back to Washington, DC.
US Air Force, Search and Rescue (SAR) Coordination	- Command and control of National Search and Rescue for inland emergencies
US Coast Guard	- Command and Control of Nat'l. Search & Rescue, Coastal zone and inland waters
State Search and Rescue Agencies	- Performance of Search and Rescue Operations
National Weather Service, Communications Division	- Forest fire, flash flood alerts
Department of Energy	- Management of nuclear emergencies, induced by nature (earthquakes) or by man (reliability failures, sabotage)
Office of Emergency Services	
Red Cross	- Emergency relief
Department of Transportation,	- Management of emergencies in connection with the transportation of hazardous matter
DOI - National Park Service	- Performance of search and rescue operations in National Park System areas. - Response to man-made emergencies and natural disasters in National Park System areas. - Management of medical emergencies in remote areas. - Response to law enforcement emergencies and alerts of terrorists or protest activities.
U.S. Department of Agriculture, Forest Service	- Forest fires Search and Rescue Law enforcement

USER AGENCY	MAJOR USE
US Immigration & Naturalization	- Interception, hot pursuit of illegal entrants
Federal Bureau of Investigation	- Hot pursuit of criminals - Hot pursuit of saboteurs - Communications from - to under-cover agents - Position of clandestine transmitters to track drugs, illegal merchandise
State National Guards	- Search and Rescue - Confrontations with Civil Riot situations
State Law Enforcement Agencies	- Law enforcement emergencies
US Postal Inspection Service	- Hot pursuit of Postal criminals
Drug Enforcement Administration	- Management of clandestine location devices - Hot pursuit of drug criminals
US Border Patrol	
Bureau of Alcohol, Tobacco & Firearms	
DOJ - Interpol Liaison	
DOJ - US Marshall's Office	
FCC Field Operations Service	- Pursuit of illegal emitters - Direction finding for SAR and
Department of Interior, Bureau of Land Management	- Management of medical emergencies on the 500 million acres which BLM controls - Data for dam bursts, other emergencies
Bureau of Indian Affairs	- Medical emergencies on reservations
GSA Federal Protection Service U.S. Customs	- Hot pursuit of smugglers
Geological Survey	- Geologic hazard warning

TABLE 2.4

PRINCIPAL AGENCIES RESPONSIBLE FOR NATURAL DISASTER MONITORING AND WARNING

DISASTER TYPE	HAZARD	RESPONSIBLE AGENCY	GEOGRAPHIC SCOPE	RECIPIENT OF WARNINGS
Meteorological	Tornadoes & severe thunderstorms	WB	All States	General Public
	Hurricanes & other tropical wind storms	WB	Atlantic & Gulf Coast States, Eastern Pacific	"
	Typhons	DOD	Western North Pacific	"
	Nontropical wind storms	WB	All States, high sea areas assigned by WMO	"
	Severe winter weather	WB	All States except Hawaii	"
	Fire danger	WB	Forested area & ranges, all States	"
	Duststorms	WB	All States west of Miss. except Hawaii & Alaska	"
	Clear-air turbulence	WB	All States	FAA
Hydrological	Flash floods	WB	All States	General Public
	River floods	WB	Main streams & principal tributaries	"
	Tsunamis	C&GS	Coastal parts of southern Alaska, Hawaii, California, Oregon, Washington, Pacific territories & possessions	
	Seiches	WB	Great Lakes	
	Storm surges	WB	Coastal parts of North Atlantic & North Pacific	"
	Icebergs and sheet ice	USCS & Navy	North Atlantic, Alaska Waters	Ships at Sea
Geophysical	Earthquakes	USGS	All States	General Public & Public Officials
	Volcanic eruptions	USGS	Western States	General Public & Public Officials
	Landslides, mudslides and subsidence	USGS	All States	General Public & Public Officials
Astrophysical	Geomagnetic & ionospheric disturbances polar cap absorption affecting radio	CRPL	Communications in all areas	General Public

WB = Weather Bureau (now NOAA)
USCG = US Coast Guard
C&GS = Coast & Geodetic Survey
USGS = US Geological Service
CRPL = Central Radio Propagation Laboratory

The typical geographic distribution of these disasters is illustrated in Figures 2.4 and 2.5. It indicates that direct disaster assistance was given to 27 states; emergencies were declared in nine states. A detailed breakdown of the causes, time of occurrence, and financial impact is given in Table 2.5.

In addition, the Administrator of the Federal Disaster Assistance Administration (FDAA) authorized fire suppression grants for forest fires in two states; the Administrator of the Small Business Administration (SBA) authorized disaster loans in 124 instances; and the Secretary of Agriculture authorized emergency loans to farmers in 249 disaster situations. SBA and the Department of Agriculture alone approved $5.97 billion in disaster/emergency loans during the year. The financial impact of the above is further enhanced by disasters which did not qualify for Federal aid.

Thirty-eight requests for assistance (49 percent of those received) were denied, but in 12 of those cases, SBA disaster loans were made available. These requests were denied because the damage, although present, was not of sufficient entity to warrant a Presidential declaration, or because sufficient help was available from other sources.

The adverse effects of disasters that can be alleviated by an Emergency Response Communications System are natural or man-induced events which pose hazards to human lives, health, property, and whose adverse effects are a function of the quickness of initial reaction. The role of an ERCS is:

- Immediate warning of impending occurrences, where such warning is not available by other means
- Announcement of the occurrence of disasters and initial assessment of severity to cognizant authorities responsible for initiating relief efforts, where such announcement cannot be provided by conventional means (tactical function)
- Provision of command and control functions to the emergency unit until normal communication channels are re-established (tactical function)
- Quick reaction replacement (QRR) of normal communications destroyed or impaired within the affected area (logistic function)

FIGURE 2.4. MAJOR DISASTER IN FISCAL YEAR 1978

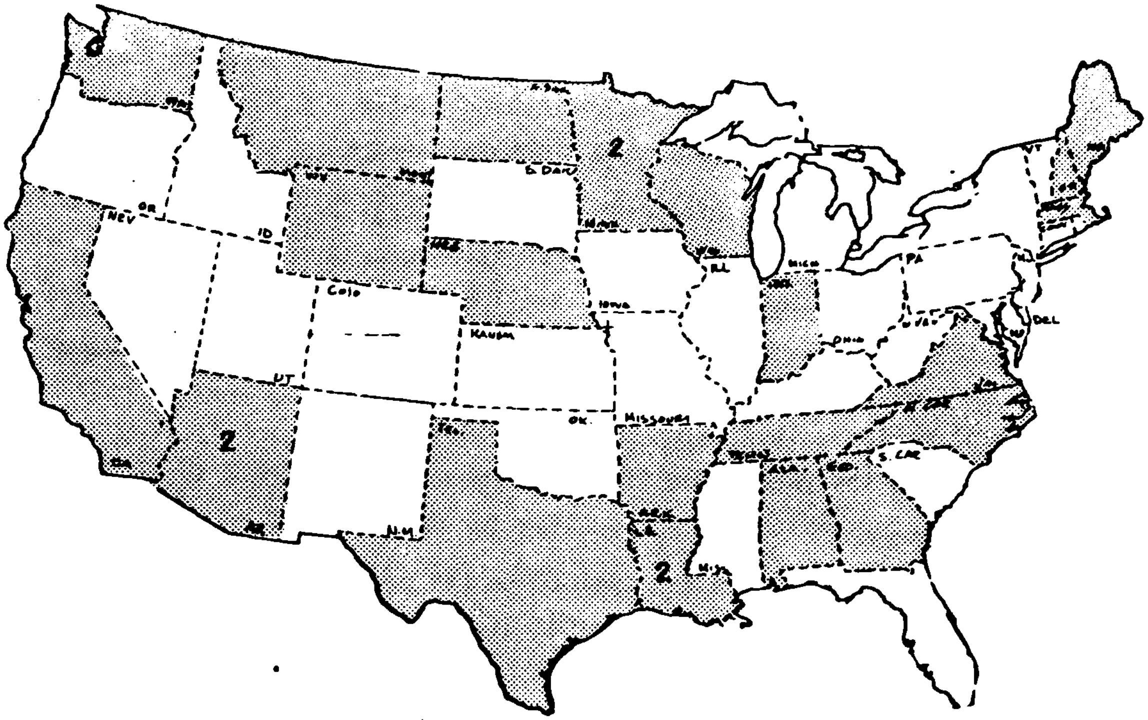


FIGURE 2.5. EMERGENCY IN FISCAL YEAR 1978

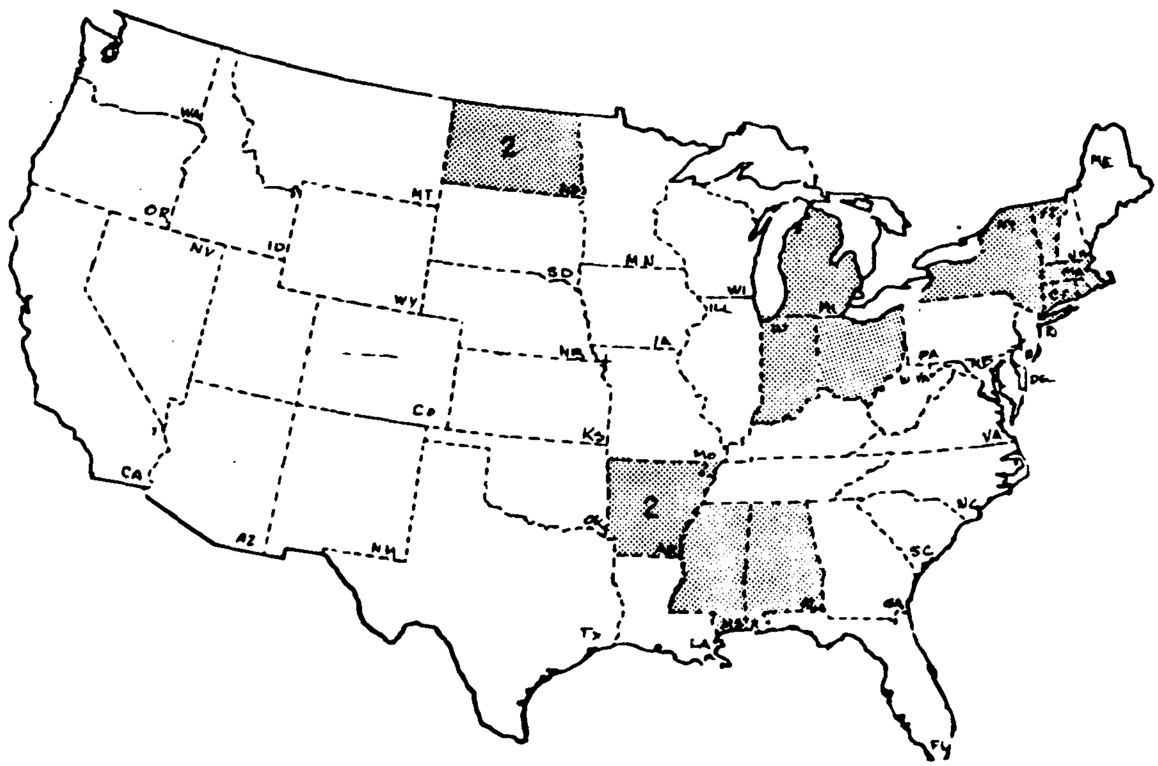


TABLE 2.5

MAJOR DISASTERS, EMERGENCIES, AND FIRE SUPPRESSIVE GRANTS, ADMINISTERED BY FDAA IN FY 78

STATE	OCCURENCE	FEDERAL ASSISTANCE ($M)
Alabama	Heavy Rain/Lightning	.8
Arkansas	Tornadoes	7.1
	Severe Storms and Flooding	9.3
Arizona	Severe Storms and Flooding	35.5
California	Coastal storms, Mudslides and Flooding	175.5
Colorado	Deer Creek Canyon Fire	.1
Connecticut	Blizzards and Snowstorms	4.6
Georgia	Dam Collapses, Flooding	2.8
Indiana	Severe Storm and Flooding	2.5
Louisiana	Severe Storm and Flooding	51.7
Maine	Winds, Tidal surge and Flooding	7.1
Massachusetts	Blizzards and Snowstorms	19.0
	Coastal Storms, Ice, Snow	170.0
Michigan	Blizzards and Snowstorms	13.0
Minnesota	Storms, Ice jams, and Flooding	3.4
	Hail and Tornadoes	23.6
Mississippi	Tornadoes	0.1
Montana	Severe Storms and Flooding	9.5
Nebraska	Storms, Ice jams and Flooding	7.7
New Hampshire	Winds, Tidal surges and Flooding	3.2
New York	Chemical Waste	2.3
North Carolina	Severe Storms and Flooding	35.5
North Dakota	Blizzards and Snowstorms	1.1
	Ice jams and Flooding	5.2
	Tornadoes	0.1
Ohio	Blizzards and Snowstorms	10.2
Oregon	Grove Crook Fire	0.1
Rhode Island	Blizzards and Snowstorms	19.6
Texas	Severe Storms and Flooding	28.3
Tennessee	Severe Storms and Flooding	5.2
Virginia	Severe Storms and Flooding	8.0
Washington	Severe Storms, Mudslides and Flooding	27.9
Wisconsin	Storms, Flooding and Tornadoes	11.5
Wyoming	Severe Storms, Mudslides and Flooding	8.2
North Marianas	Tropical Storm	1.8
	TOTAL for 26 Disasters, 13 Emergencies 2 Fires	727.4

- Relay of disaster occurrence and status (assessment) to cognizant authorities (strategic function).

2.2.3.1 Natural Disasters. Figures 2.6 and 2.7 depict the average yearly number of natural disasters and of corresponding deaths, by regions of the world, and for the U.S. and North America, in particular. The corresponding yearly loss of life is approximately 400; the estimated average yearly property and other monetary loss is $3 billion. These figures apply only to catastrophic occurrences falling within the general purview of emergency communications. They do not include occurrences such as drought, which, although disastrous if widespread and acute, is relatively slow to develop, and can be coped with by normal communications channels.

Disasters of interest to ERCS are characterized by suddeness and/or geographically random occurrence. This places a costly burden on remedial or protective actions prior to their occurrence. A principal measure for mitigating the effects of disasters is the availability of extensive monitoring and warning networks, coupled with effective relief organizations and with ERCS to provide alert and immediate command and control functions. It is in part due to the high level of development of warning and communications systems that the United States suffers relatively little from disasters when compared with the lesser developed areas of the world.

Table 2.6 depicts the average yearly distribution of damage from disastrous occurrences in the United States. It shows that not all types of disasters are equally deleterious on the average. This is due to the

TABLE 2.6
DISTRIBUTION OF LOSSES FROM DISASTERS BY TYPE IN THE U.S.
20-YEAR AVERAGE 1947 - 1967

TYPE OF DISASTER	% LOSS OF LIVES	% PROPERTY DAMAGE
Severe Weather, Tornadoes, Hurricanes, Thunderstorms	60	35
Blizzards and Snow-storms	25	10
Floods	11	50
Earthquakes	3	5
All Others	1	-

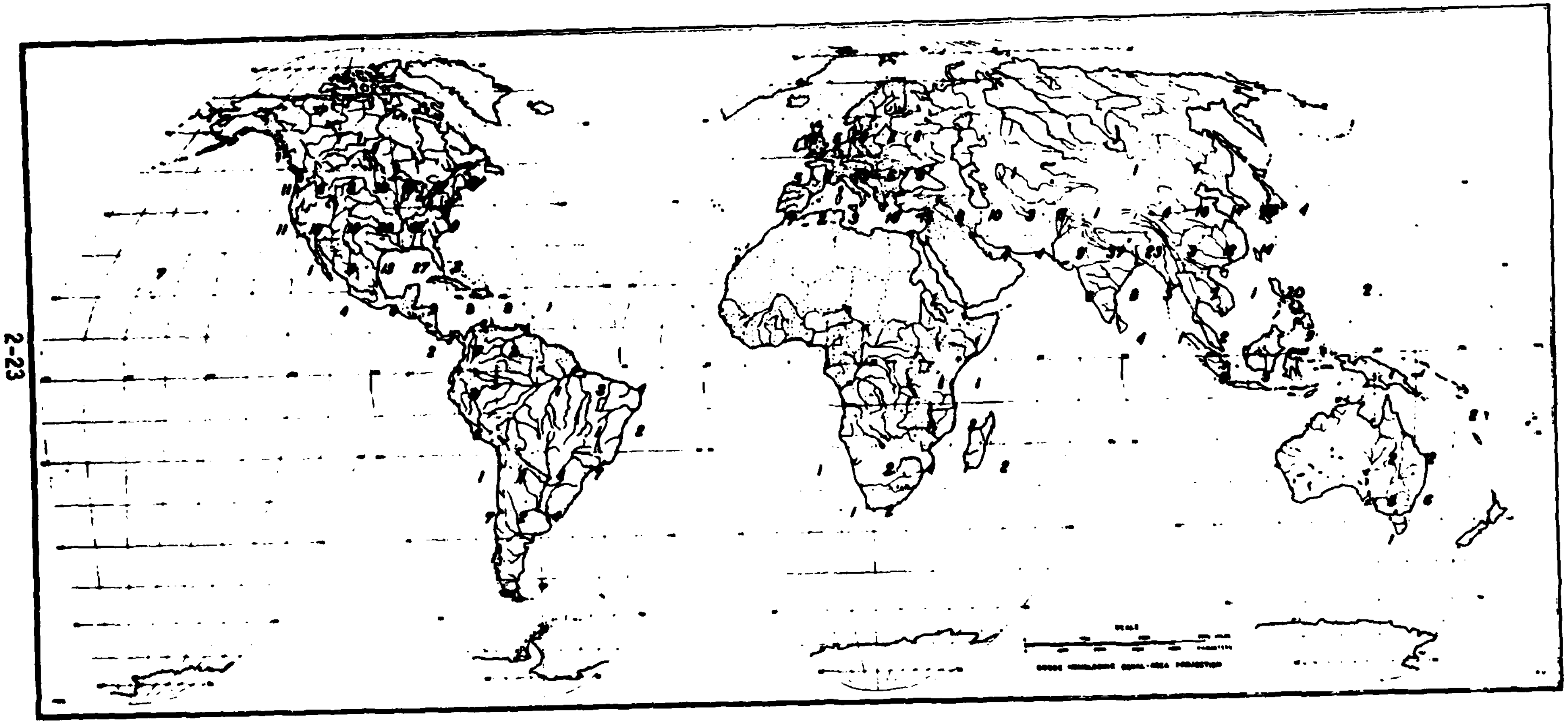


FIGURE 2.6. AVERAGE YEARLY NUMBER OF "DISASTROUS IMPACTS" BY 10^o SQUARES 20 YEARS, 1947-1967

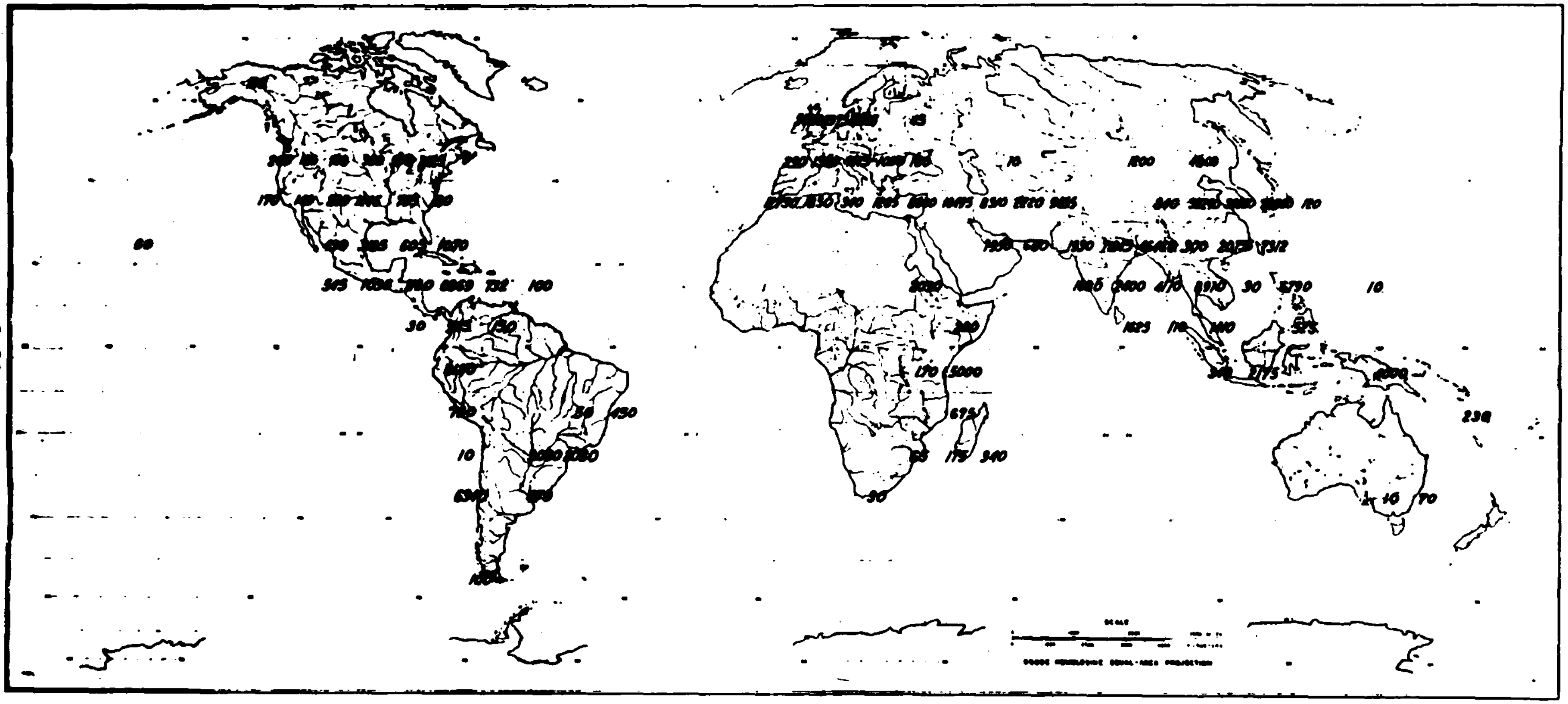


FIGURE 2.7. AVERAGE YEARLY NUMBER OF DEATHS PER "DISASTROUS IMPACT" BY 10° SQUARES 20 YEARS, 1947-1967

combination of: the impact of any one event, the frequency of occurrence of that type of event, and the local density of population and property risk. For example, severe earthquakes occurring within urban areas cause very major damage per event; yet their frequency of occurrence is low; thus, the average damage is less than that accruing to severe storms, which have less impact per event, but which reoccur with much greater frequency.

Average figures such as those of Table 2.6 in no way should be interpreted to indicate that the less frequent but potentially highly damaging events should receive less emphasis. What they do indicate is that the alert and relief procedures, including the structure of ERCS deployment, should be configured in two aspects:

1. ERCS for frequently reoccurring events - thus in relatively continuous usage

2. ERCS provision for secular recurrences.

Figure 2.8 shows the geographical distribution of the incidence of the natural disasters summarized in Table 2.6. Of these, the meteorological types qualify for the designation of frequently reoccurring events: earthquakes qualify as secular occurrences. Tsunamis classify as having recurrence frequencies in between earthquakes and meteorological-type disasters. Table 2.7 further illustrates this point by listing the average yearly frequencies of occurrence of the various disastrous events.

Floods. Either normal riverline flooding or flash floods in hilly terrain have accounted for the bulk of Federal disaster assistance throughout the history of the program. Twenty-two of the 26 major disasters declared in 1978 were declared primarily for flooding, and 64% of the $324 million obligated from the President's Disaster Relief Fund was directed to these disasters.

The losses of life and property are shown separately for the U.S. and the world in Figure 2.9. River and flash floods cause the greatest economic losses resulting from natural disasters in the U.S., averaging nearly $2 billion annually, and taking an annual toll of almost 100 lives. Deaths from flash floods are now approaching 200 per year as compared to an average of less than 70 per year during the preceding 30-year period. Property losses from flash floods are now nearly 10 times what they were in the 1940's.

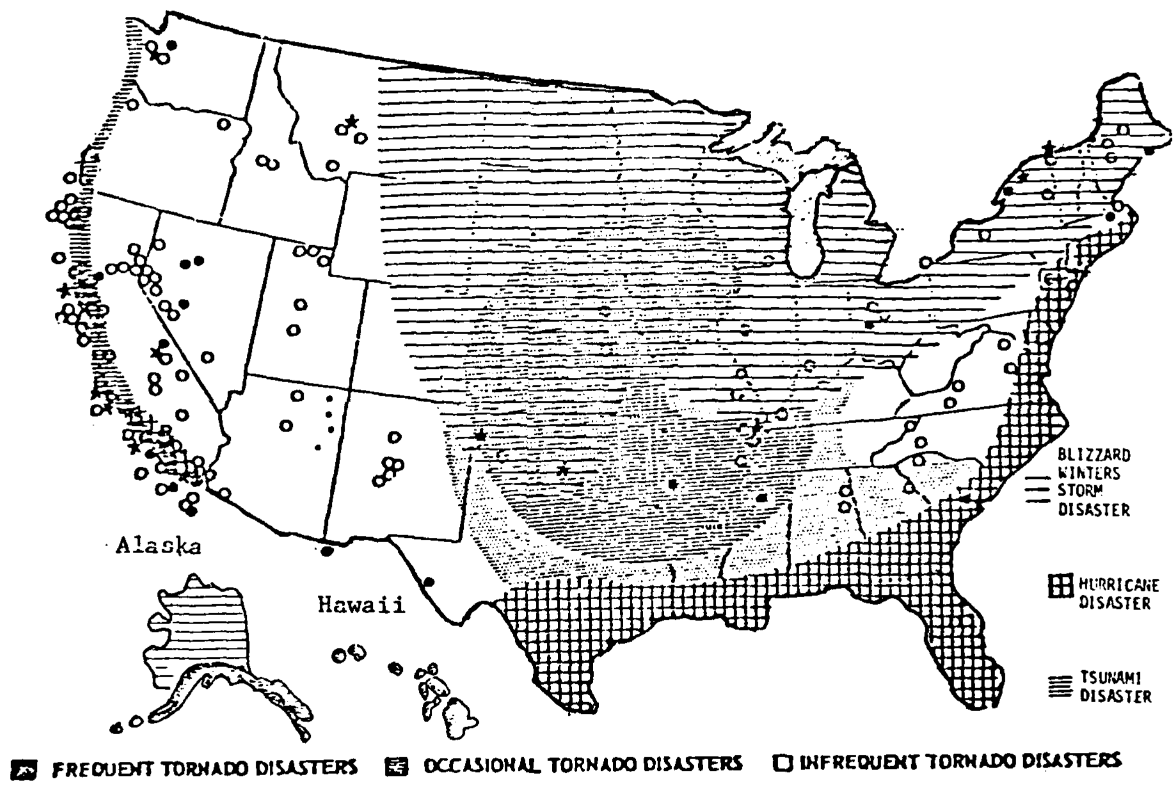


FIGURE 2.8. GEOGRAPHIC INCIDENCE OF PRINCIPAL NATURAL DISASTERS

TABLE 2.7

AVERAGE YEARLY FREQUENCY OF OCCURRENCE OF PRINCIPAL DISASTROUS EVENTS IN THE U.S.

TYPE OF DISASTROUS PHENOMENON	FREQUENCY, AVERAGE NO. OF EVENTS/YEAR
Tornadoes and Severe Thunderstorms	600
Hurricanes	3
Snowstorms & Blizzards	10
Earthquakes Causing Damage $1M	1.5
Floods	40
Flash Floods	20
Tsunamis & Tidal Waves of Major Import	2

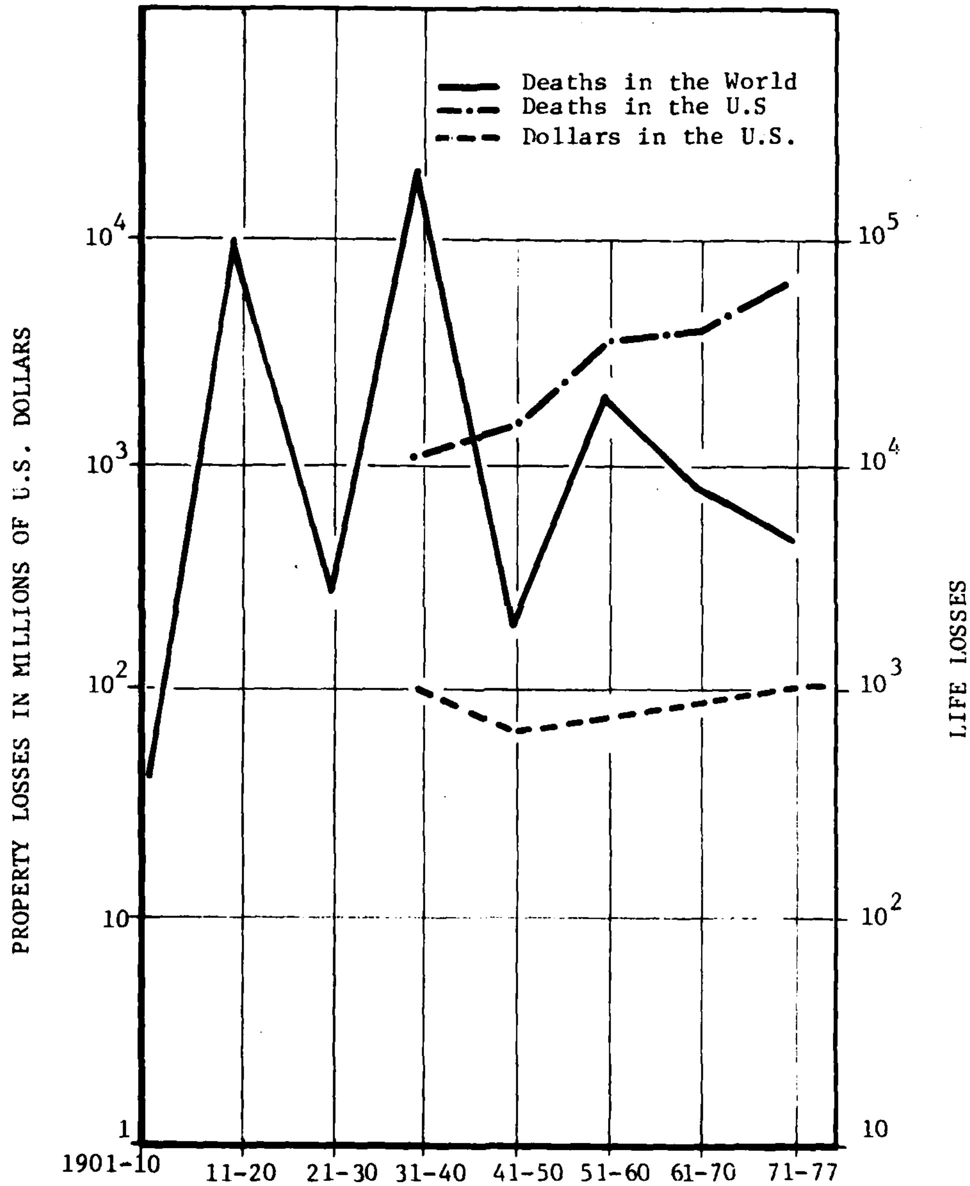


FIGURE 2.9. DAMAGE CAUSED BY FLOODS AND FLASH FLOODS IN THE TWENTIETH CENTURY

A flash flood occurs when water rises and falls quite rapidly with little or no advance warning, usually as the result of intense rainfall over a relatively small area. Flood damage can be attributed to four major causes: severe tropical storms, snowmelt, severe thunderstorms, and by storm-induced occurrences like dam breaks.

Hurricanes. Personal communication with Chief of Records and Evaluation at FDDA indicates that "hurricane is probably the number one cause of large scale disasters which require emergency communication systems." The Celia hurricane of 1970 hit Corpus Christi. This disaster caused a loss of 97% of station lines and overhead cable. Celia was a dry hurricane with high tornadoes creating severe wind damages. These winds destroyed roughly 55% of the trunk lines. The remaining 45% were so severely overloaded as to effectively produce a communications blackout.

The setting up of emergency communications in this particular case entailed:

1. Setting up an emergency link to the Houston telephone system via radio (type: KWMX) located in the basement of a nearby police station. This allowed communications with the Civil Defense Center and National Headquarters in Washington.

2. Establishing a 100-watt base station, linking 20-25 Motorola walkie-talkies (type: PT400s). These were used to maintain communications between key Federal level staff.

3. Granting permission to the telephone company to initiate "priority restoration" to the area under the FCC guidelines. Immediate communications with key places such as hospitals and police stations were established.

Disaster alleviation activities required the assistance of approximately 400 Federal employees. The field office and temporary stations cost approximately $9,000, not including the cost of the equipment which was Federally owned. Five equipment operators were required for 5 days.

Flash floods which destroy existing communications systems do occur, albeit infrequently. The flood at Johnstown wiped out all existing commer-

cial systems. Emergency communications were linked up with the Federal System. Satellite communications were also utilized.

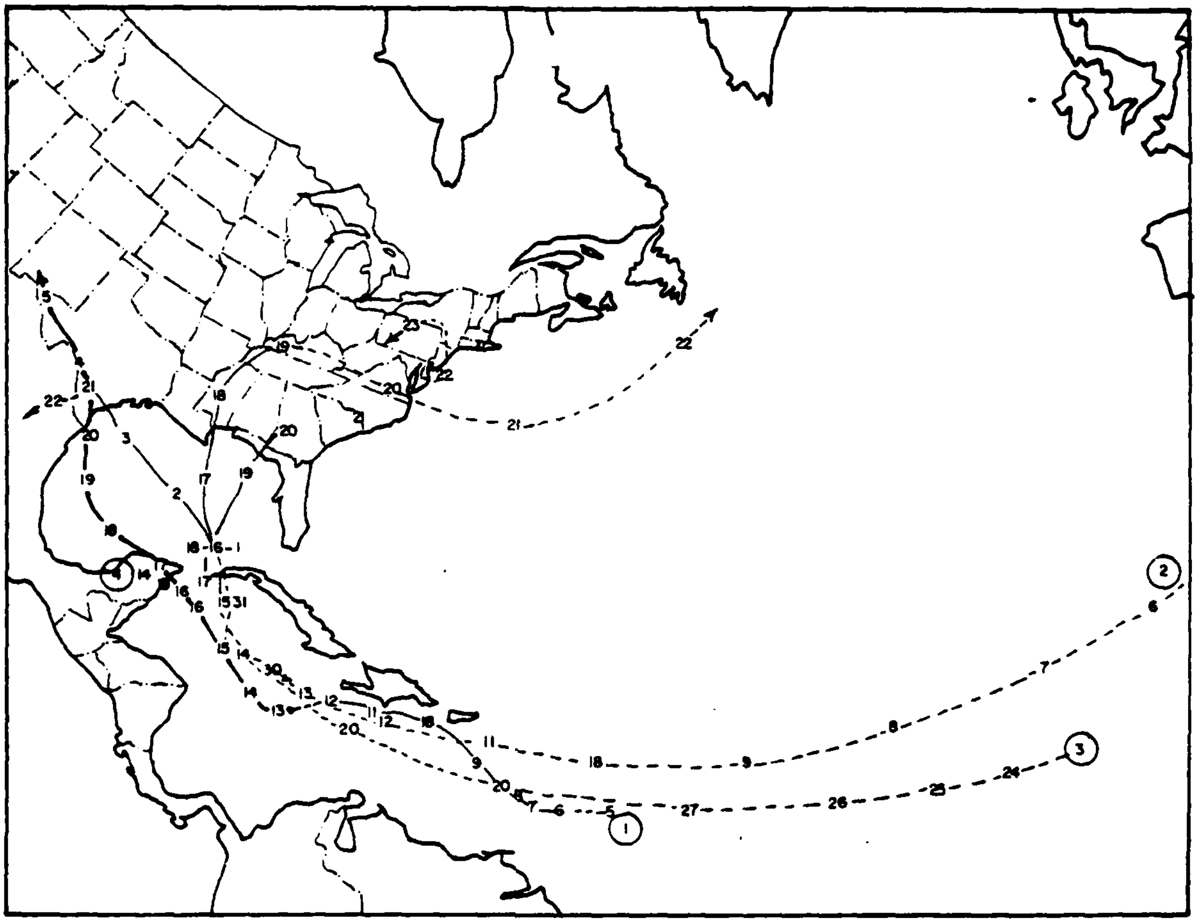
Figures 2.10 and 2.11 illustrate the impact of recent hurricanes in the U.S. The impact on communications and hence, the potential value of ERCS, is summarized for these in Table 2.8.

2.2.3.2 Man-Made Disasters. Man-made disasters are potentially more significant in terms of loss of lives, damage to property, and hazards to health. Not many decades ago, man-made disasters other than war were relatively of minor effect. Although the costs of war are significant, they will not be considered in this section. Technological growth has brought to the fore the actual and potential incidence of explosions, chemical spills, and catastrophic oil spills. An example of a potentially severe disaster -- fortunately not realized in this case -- is the recent impact of Soviet satellite debris within Canadian territory. Corresponding regulatory action is currently being debated within the U.S.

Far more ominous is the possibility of nuclear accidents, either caused deliberately by subversive activities or arising from failure of safety systems; for example, in nuclear breeder reactors.

Figure 2.12 depicts the cumulative occurrence of major oil spills (in excess of 10,000 gallons) on the world's oceans during the six-year period 1968-1974. Note the preponderance of spills occurring near the U.S. coastline. Even more preoccupying is the very rapid growth of these incidents: from six worldwide in 1968 to 33 in 1974, a compound growth rate of 30% per annum.

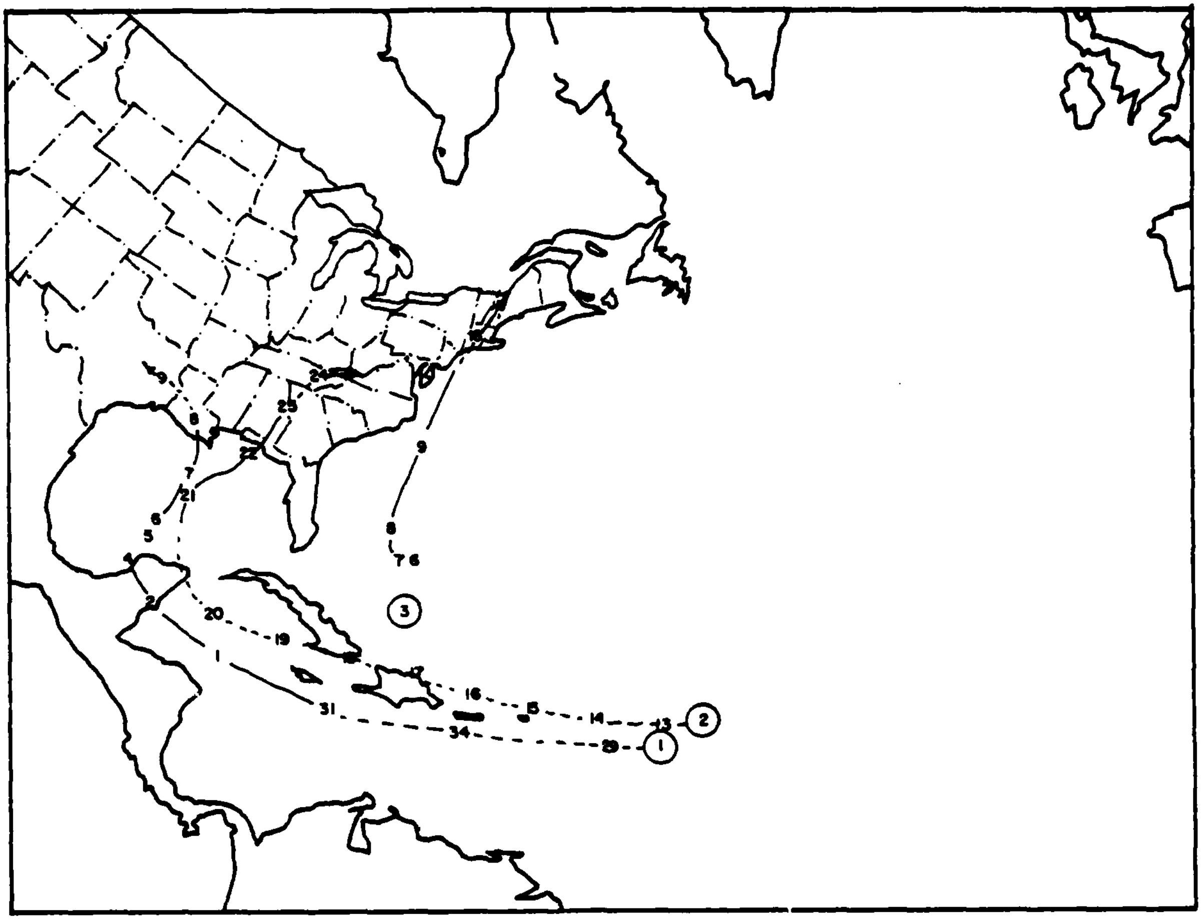
Reported chemical incidents in the U.S. number on the order of 10,000 per year. Of these, approximately 30% represent genuine emergencies: approximately 1% can be classed as disastrous occurrences, threatening primarily lives. Typical examples are the 1977 Youngston, Florida train accident which released an entire tank car's deadly chlorine contents; the Kepone 1977 spill in Chesapeake Bay; various recent spills of truckloads of sulphuric, arsenic, hydrochloric acid and radioactive gases. Chemtrec, a Washington, D.C. organization which provides round-the-clock alert and QRR advice to all parts of the U.S. on how to cope with chemical emergencies, states that the key to efficient protection is the rapid conveyance of adequate information. They further state that there are cases where hours elapse before Chemtrec is notified.



---Pre and Post Hurricane Stages
——Hurricane Stage

DATES OF HURRICANE	AREAS MOST AFFECTED	LAND STATION WITH HIGHEST WIND SPEED*	DEATHS (U.S. ONLY)	DAMAGE BY CATEGORY ±	DAMAGE
1. 1967, September 5-22 BEULAH	Southern Texas	Brownsville, Texas, gust, 109 mph measured with damaged anemometer.	15	8	Major floods in southern Texas, killing 10 people and causing most of damage. Record number of tornadoes — 155 — which killed 5 persons.
2. 1969, August 14-22 CAMILLE	Mississippi, Louisiana, Alabama, Virginia, W. Virginia	Gulfport, Miss., E 100 mph, gusts 150-175 mph;	255 dead 68 missing	9	Storm tide up to 24.2 feet above sea level in the Pass Christian-Long Beach, Miss. area. 27 inches of rain in 8 hours caused severe flash floods in Virginia resulting in 109 deaths with 41 persons missing.
3. 1970, July 23-August 5, CELIA	Texas	Corpus Christi, Tex. 130 mph, Gusts 161 mph	11	7	Greatest damage in west to east streaks where maximum gusts occurred. Costliest hurricane ever to strike Texas.
4. 1972, June 14-23, AGNES	Florida to New York	Key West, Fla. 43 mph; Jacksonville, Fla. gusts 56 mph. Storm tide 6.4 ft. above normal Apalachicola, Fla.	122	9	One of the costliest natural disasters in U.S. history — $2.0 billion. Devastating floods from North Carolina to New York with many recordbreaking river crests. Tornadoes—15 in Florida and 2 in Georgia.

FIGURE 2.10. IMPACT OF HURRICANES, 1967-79



– – – Pre and Post Hurricane Stages
——— Hurricane Stage

DATES OF HURRICANE	AREAS MOST AFFECTED	LAND STATION WITH HIGHEST WIND SPEED*	DEATHS (U.S. ONLY)	DAMAGE BY CATEGORY#	DAMAGE
1. 1974, August 29 September 10 CARMEN	Southern Louisiana	Morgan City, La. 86 mph	1	8	Primarily to sugar cane crop.... also offshore oil installations and the shrimping industry.
2. 1975, September 13-24 ELOISE	Florida Panhandle and eastern Alabama	5 miles northwest of Ozark, Ala., 104 mph	4	8	Major (almost total) storm surge and wind damage to structures along beach strip from Fort Walton Beach to Panama City, Fla. High winds destroyed property and crops over eastern Alabama. Flooding and miscellaneous damage from heavy rains over northeastern U.S.
3. 1976, August 6-10 BELLE	New York, New Jersey, and southern New England	Bridgeport, Conn., gusts to 77 mph	5	8	Crop damage in the Northeast, some caused by salt spray. Considerable inland stream and road flooding. Estimate half-million persons evacuated coastal areas.

FIGURE 2.11. IMPACT OF HURRICANES, 1973-1976

TABLE 2.8

EXAMPLES OF THE EFFECT OF EMERGENCIES ON EXISTENT COMMUNICATIONS SYSTEMS AND RELEVANT ASSOCIATED DATA ON GIVEN EMERGENCIES

Type of Hazards	Date	Damage-Stricken Area	No. of Phone Connections Destroyed	Factors	Emergency Efforts Made By Bell	Cost to Bell	Time To Restore Service
HURRICANES							
1) Celia	August 3, 1970	South (TX)	94,000	High Winds	a) alert b) bussed in 75 c) W.E. Equipment trucked in d) emergency generators to power switchboard e) extended working hours f) customer surveys g) emergency phone booths installed		
2) Agnes	June 21-22, 1972	East (VA, MD, DE, NJ, NY, PA)	400,000	High Winds, Rain (>9")	a) rechanneling of calls b) 140 tons of W.E. equipment: delivered: (i) 174,000 phones (ii) 370 m. feet of conductor exchange cable (iii) 490 tons connector cable, cords and dropwire (iv) 4 tons transmissions equipment c) used 2 dozen emergency diesel generators d) interdepartment Storm Emergency Control Center utilized	>$33 million	5 Days
3) Beulah	Sept. '67	South (TX)	60,000			>2.5 million in equipment	
4) Betsy	1965	South (FA, LA, MS)	>520,000	Winds	a) called in out of state workers b) rushed in W.E. equipment (i) 10 m. feet of pole to house wire (ii) 200 m. conductor exchange cable (iii) 2 m. feet special type of wire	$16 million	<2 weeks
FLOODS							
1) Unnamed		VA, W. Va., TE, KY	>46,000			>$10 million	

FIGURE 2.12. MAJOR OIL SPILLS THAT HAVE OCCURRED ON THE WORLD'S OCEANS, 1968-1974

Nuclear incidents, such as the one at Three-Mile Island, thus far have been contained, thanks primarily to exceptional precautions taken by responsible U.S. agencies. Catastrophic explosions are not expected from nuclear power-generating plants, including those of the breeder type. Immensely significant, however, is the potential for failures releasing nuclear debris into the atmosphere (fallout). While the foreseeable probability of such occurrences is very small (one computation puts it at one chance in 500 million), the potential threat to life is huge. In addition, extremely high damage is potentially possible from prolonged fallout of long-lived isotopes which would render the area affected uninhabitable essentially forever -- plutonium, for example, has a half-life of 24,000 years.

Private insurance companies will not underwrite more than $65 million for any one civilian nuclear catastrophe. The U.S. Government's limitation of compensation to victims is $500 million, which is insignificant if one visualizes a severe fallout on New York, Chicago, or Los Angeles.

As far as is known today, disasters of this magnitude are possible only from simultaneous failure of all fail-safe mechanisms within a nuclear reactor, or as a direct result of war. The time lapse from the beginning to the identification of the catastrophe could be as short as hours. Emergency communications to provide instant alert and to supply competent technical advice could spell the difference between a mishap and the largest catastrophe ever experienced by man.

2.2.4 Emergency Medical

The principal use of communications in medical emergencies is the rapid assistance to, and recovery from, acute and traumatic conditions.

Rural areas exist in the United States wherein the advantages of improved emergency response communication is particularly important. The experience of the Southern Regional Research Council and the Arcadian Ambulance Service in the Mississippi-Louisiana area is an effective case in point. There are two EMS systems in the area which would benefit from improved coverage and lowered costs:

- A public funded EMS system covering 4,000 sq mi in Mississippi.
- A 10,000 sq mi private (subscription) service. The private system, which covers the more rural area, collects $28/year from each subscriber family. The total revenue of approximately $3M/year covers the EMS equipment, EMS personnel, and the EMS communications. Non-subscribers pay a $90/call use charge.

In conjunction with this system, the Arcadian Company also services the 60,000-man offshore oil drilling population. The drilling rigs are an important source of EMS cases. Most of the trauma incidents occur on the drilling rigs as opposed to the production rigs. They generate some 4-12 major trauma cases per month. They are completely without communication networks.

The Arcadian Service has recently placed into service 4 portable ATS type communications (≈ $1,200), one at each of 4 helicopter staging areas. Continuous communications with the helicopter-borne paramedics is expected to provide significant benefits to oil company workers, some of whom are stationed up to 200 miles offshore. Arcadian indicates that already the stationing of paramedics on the helicopters has lowered insurance rates. Arcadian further indicated that the insurance premiums saved would be far greater than the cost involved.

Rural ERC/EMS is also interesting to other large industries in the area. For example, the St. Regis Paper Company at Monticello, Mississippi, located 70 miles from the nearest trauma care facility, indicates that the lowering of insurance rates would pay for a complete medical team and ambulance.

It is clear that only a fraction of the deaths is amenable to saving from emergency action, specifically that fraction for which actions of any type can prevent death. Within this fraction, crucial to recovery from severe forms of acute and traumatic conditions is the quick supply of aid: first, on site; subsequently, in establishments equipped with the proper medical facilities. Within the "savable" fraction, the cause-effect relationship between the time delay in administering aid and the mortality rate varies significantly as a function of the type and severity of injury, and the state of health and bodily resistance of the individual affected. Another important consideration

is the reduction of permanently disabling injuries potentially achievable from rapid reaction.

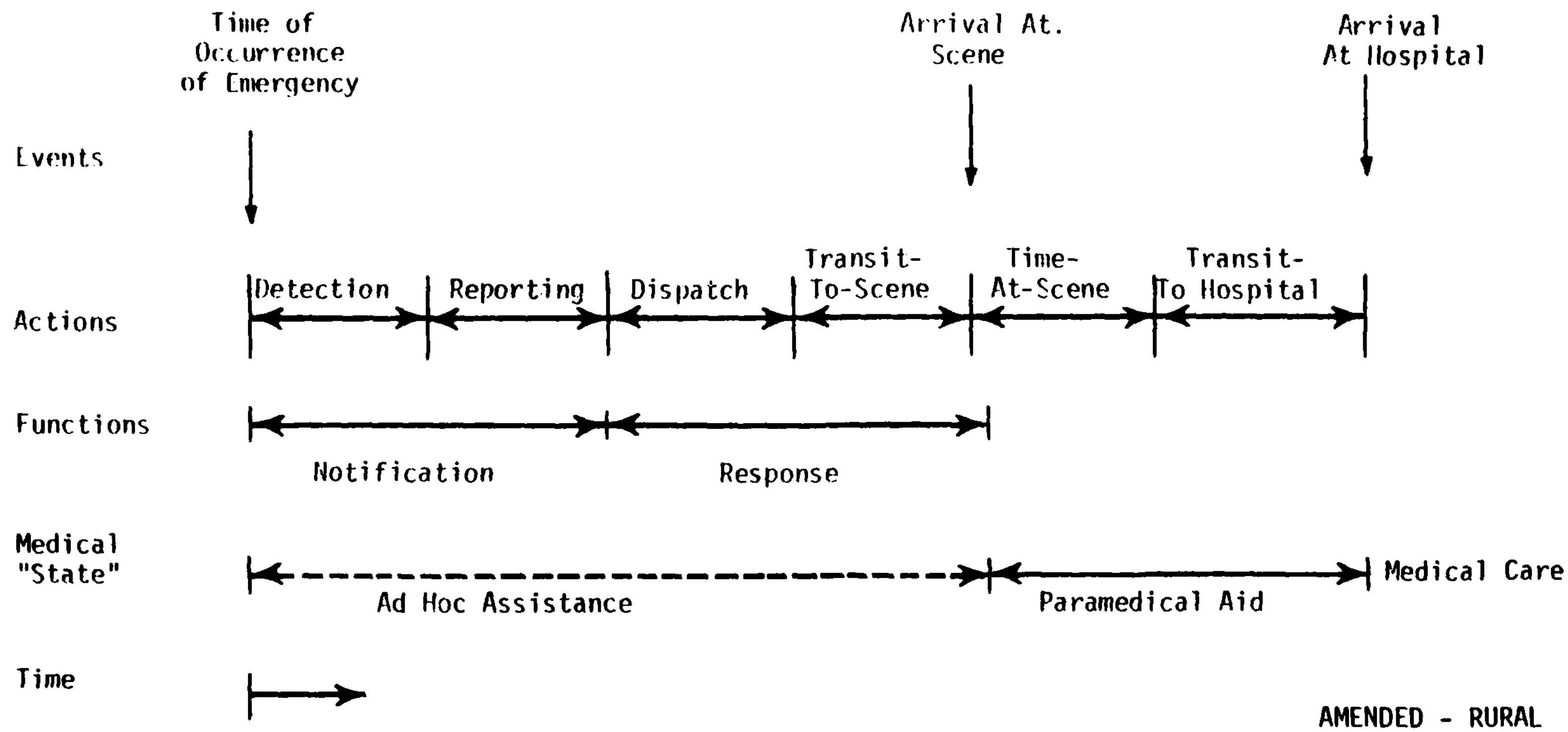
Figure 2.13 depicts typical delays incurred in urban and rural areas. The following points emerge:

- The notification delay, imputable to communication, is relatively small in typical urban areas, more significant in rural locations. Thus, ERCS would primarily serve the latter. Considerable judgment needs to be exerted in configuring the system. Because it is probably unreasonable to provide communications facilities to all potential victims of accidents, initial implementations may be designed to provide suitable communications facilities to those already affected by medical conditions, or to those laboring in particularly hazardous environments.

- Upon arrival at the scene, first aid is supplied to the victim by paramedics. At this time, and during the subsequent transit to the hospital, ERCS can assist in providing two-channel voice and data communications: verbal descriptions from paramedics to physician(s), telemetry of vital signs from the instrumented victim to physician(s), and verbal instructions from physician(s) to paramedics. This service is already provided in many localities, and is expanding. Thus the major ERCS applicability is in areas not endowed with such services, if the ERCS implementation is cost-competitive with the provision of conventional ambulance service. This is supported by the fact that the mortality rate from accidents and heart attacks in rural areas is fourfold that of urban areas.

- A special case is presented by the occurrence of disasters which tend to destroy or saturate the existing medical service.

- It is clear from the example illustrated in Figure 2.13 that a reduction in EMS response time in rural areas could produce



	URBAN, Mean delay, minutes	GENERALIZED RURAL, min-max. delays, minutes	AMENDED - RURAL FROM A CADIAN AMBULANCE SERVICE EXPERIENCE
Notification	8	10 - 60	-
Dispatch	3	-	0.5 - 1.0
Transit to Scene	4	10 - 30	5 - 20
Time at Scene	4	5	5 - 10
Transit to Hospital	5	20 - 45	30 - 120
TOTAL	24	$45^+ - 140^+$	$41^+ - 151^+$

FIGURE 2.13. TYPICAL MEDICAL EMERGENCY RESPONSE DELAYS

a substantial reduction in accident fatalities, particularly in those accidents involving decisive injuries.

2.2.5 Law Enforcement

This function is well covered in the metropolitan areas by existing law enforcement communications networks. The major impact of an ERCS on the law enforcement field is within areas where conventional coverage does not exist or is overloaded as the result of an emergency.

In interviews with FBI officials, the MITRE Corporation queried the FBI to identify and rank the most serious problems of the Bureau's communications system. The results are summarized below:

Rank	Problem Area
1	Lack of sufficient coverage
2	Expense/high cost
3	Character of area/terrain causing dead spots
4	Unauthorized monitoring
5	Difficulty in rapidly deploying communications in remote areas for special activities.

The FBI response emphasizes the coverage problem and the concern for cost. This points out the improbability of near-future extension of coverage throughout the CONUS. This service can be further enhanced by providing security.

Table 2.9, also from the MITRE study, indicates the key functional requirements for future law enforcement communications systems.

An ERCS could aid greatly the whole spectrum of Federal law enforcement agencies. For example:

- U.S. Customs Services
- Drug Enforcement Administration
- Immigration and Naturalization Service
- U.S. Park Police

TABLE 2.9

POSSIBLE KEY FUNCTIONAL REQUIREMENTS FOR FUTURE LAW ENFORCEMENT COMMUNICATIONS SYSTEMS

	AGENCY TYPE		
FUNCTIONAL AREA	FEDERAL	STATE	COUNTY
PERFORMANCE (quality signal)	E/B	E/B	E/B
COVERAGE (over large geographic areas, remote, urban)	Significant Increase Over Current	Minor Increase Over Current	No Increase Over Current
INTERAGENCY COMMUNICATIONS INTEGRATION	Yes	Yes	Yes
PRIVACY AND SECURITY	Yes	No	No
DATA TO VEHICLES	No	Minor	No
COMPATIBILITY WITH CURRENT SYSTEM	Yes	Yes	Yes
RELIABILITY	E/B	E/B	E/B
FLEXIBILITY TO EXPAND/ADD NEW CAPABILITIES	Yes	Yes	Yes

E/B = Equivalent or Better than Current

- Bureau of Alcohol, Tobacco and Firearms
- U.S. Secret Service
- U.S. Postal Service
- Internal Revenue Service
- U.S. Department of Agriculture
- U.S. Coast Guard.

2.2.6 Search and Rescue (SAR)

The data shown herein were generated by the ICSAR ad hoc working group on Satellites for Distress Alerting and Locating, Final Report of October 1976, and compares yearly flight hours actually expended in SAR operations against those which would have been expended had an improved SAR communications system been available. Data has also been obtained from the National Park Service on SAR operations in 1976 and 1977.

SAR activities within the inland region, Civil Air Patrol (CAP) operations accounted for 22,368 aircraft hours flown for SAR purposes in 1974; military operations accounted for 11,289 flight hours. In all, 19,231 of the CAP hours and 4,826 of the military hours flown were in search of downed civilian aircraft; 2,260 military and 2,260 civilian hours would probably have been flown for actual command, control, and rescue operations, even with a perfectly functioning SAR system. This leaves a potential of 16,971 CAP flight hours and 2,566 military flight hours that could have been avoided with a "perfect" system, with a potential cost savings to the Federal Government of $5.6 M, and an additional savings to CAP and state governments totalling $.4 M.

The National Park Service has responsibilities for all search and rescue operations in the National Park System as shown in Table 2.3. The geographical distribution of the National Park System is shown in Figure 2.14. The data for 1976 SAR activities is given in Table 2.10; Table 2.11 gives the data for 1977.

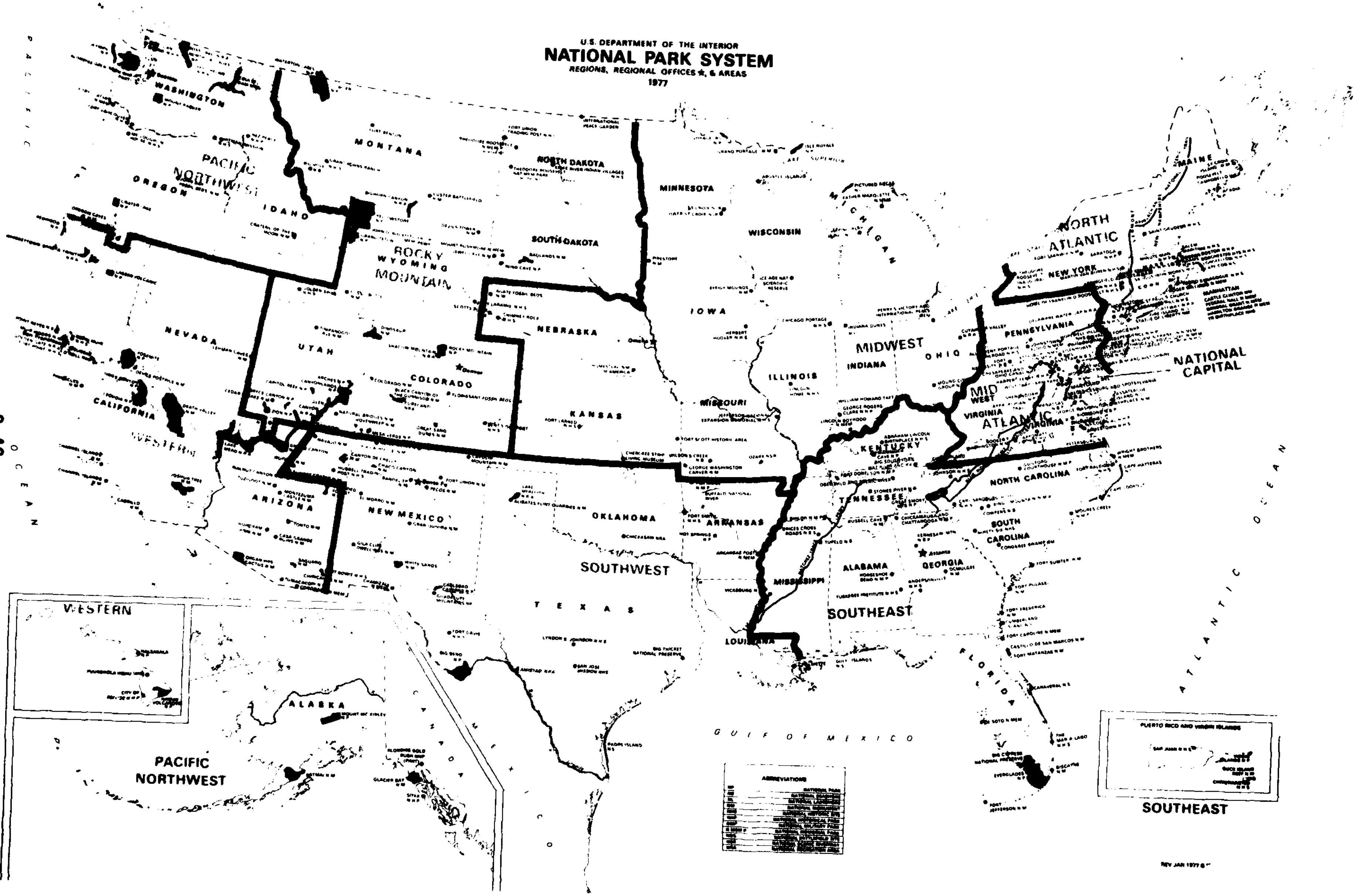


FIGURE 2.14. NATIONAL PARK SYSTEM

TABLE 2.10

1976 NATIONAL PARK SERVICE SEARCH AND RESCUE DATA

(For following Regions: Rocky Mountain, Southwest, Western, Pacific Northwest and part of Middle Atlantic. See enclosed map for regional boundaries.)

Total search and rescue (SAR) incidents 1,560*

Total visitors involved: 2,919

Types of Incidents (Visitors involved)

Lost persons	812	
Air Crash	12	
Illness	250	
Drownings	38	
Miscellaneous Accidents	1,591	(includes some boating SAR)
Climbing	213	
	2,919	

Action Taken

Stranded persons rescued	1,123	
Injured persons provided first aid and evacuation	538	
Fatalities	81	(not included: all boating fatalities)

Method of Evacuation

By person's own power	309
Carried by rescuers	198
By horse, mule or dogsled	154
By aircraft	411
By boat or other means	181

Search and Rescue Man Hours Used

NPS - regular	9,334	
NPS - overtime	8,204	
Non-NPS	4,447	
	21,985	manhours (equivalent of 10 men working 1 year)

* Total incidents for the entire National Park System: 2,841 (Reporting procedures for regions other than those cited above do not provide itemized data.)

TABLE 2.10 (Cont.)

Costs	
NPS programmed costs	$101,676 (Regular Ranger time)
NPS costs not programmed (overtime, volunteer meals, etc.)	275,172
TOTAL NPS COSTS	376,848
Costs paid by other agencies	253,764
Total SAR Costs	$630,612
Cost per incident	$223
NPS cost per incident	$133
Cost per individual	$217
NPS cost per individual	$126
Climbing Data	
Climbers requiring technical SAR techniques	213
Programmed costs	$14,890
Costs not programmed	$138,924
NPS Climbing Rescue Costs	$153,814
Costs paid by other agencies or persons (estimated)	62,890
Total Climbing SAR Costs	$216,704
Total cost per rescued climber	$1,229
NPS cost per rescued climber	$722

TABLE 2.11

U.S. DEPARTMENT OF THE INTERIOR - NATIONAL PARK SERVICE
SEARCH AND RESCUE OPERATIONS - 1977

NAME OF REGION	NUMBER OF INCIDENTS	NUMBER OF PERSONS/TYPE OF INCIDENT						NO. OF PERSONS RESCUED FROM STRANDED POSITION	NO. OF PERSONS INJURED	NO. OF FATALITIES	METHOD OF EVACUATION					MAN HOURS			REGION NPS – SUMMARY COSTS		
		LOST PERSON	AIR CRASH	ILLNESS	DROWNING	MISC. ACCIDENT	CLIMBING				OWN POWER	FOOT	ANIMAL	AIR	OTHER	NPS REG.	NPS O.T.	NON-NPS	PROGRAMMED (RANGER REGULAR TIME)	NOT PROGRAMMED (O.T., W.A.E., EQUIP., ETC.)	COSTS PAID BY OTHER AGENCIES OR PERSONS (EST.)
MID-ATLANTIC	77	84		6		24	5	9	24	4	66	14		1	36	398	188	119	4,754	2,658	1,560
MIDWEST	54	40		2	3	38	1	50	13	3	16	7		4	35	535	181	123	2,954	2,829	1,018
NORTH ATLANTIC	750	547		191	8	12	1	263		6	540	9			361	968	139	606	7,431	2,391	561
NATIONAL CAPITAL	192	71		6	9	122	32	157	105	10	78	20	1	3	72	468	168	512	2,851	2,270	4,672
PACIFIC NORTHWEST	92	68		10	9	22	41	83	45	18	33	31	3	72	9	2,734	2,933	2,001	12,327	34,660	131,038
ROCKY MOUNTAIN	136	136	1	20	7	64	53	[illegible]	63	19	102	44	5	27	69	2,079	2,835	1,168	11,543	57,704	15,040
SOUTHEAST	417	131	8	20	11	224		394	42	14	46	50		4	95	2,352	576	1,530	14,077	9,044	16,566
SOUTHWEST	104	80	2	14	7	61	3	126	10	17	36	19	3	6	76	946	669	1,582	5,808	10,366	9,768
WESTERN	794	144	9	317	25	331	68	888	346	55	161	100	40	447	122	4,547	2,876	1,902	27,160	90,995	129,386
GRAND TOTAL	2,616	1,301	20	586	79	898	204	2,132	648	146	1,078	294	52	564	875	15,027	10,565	9,543	88,905	212,917	309,609

2.2.7 Development of ERCS Requirements

The ERCS overview presented in this section is intended to quantify the environment of applicability of ERCS. The salient conclusions emerging from this investigation are:

1. The requirements for an ERCS are most evident in the disaster area, where the role of the ERCS is twofold:
   - Temporary replacement of disrupted communications
   - Alleviation of saturation of communications channels.
2. The gross market for ERCS is also the largest in the disaster area. This area is thus prima facie the best candidate for further analysis of the addressable market.
3. Within the area of natural disasters, hurricanes account for the largest apparent need for ERCS, closely followed by floods.

   Earthquakes present a special challenge to the systems implemented because of their characteristic of infrequent occurrence coupled with large damage per major event.
4. Man-made disasters present a special opportunity because of their expected growth trend. It could become a most valuable adjunct to the latter, especially in view of the potential savings achievable by the integration.
5. A key application of medical ERCS is in conjunction with natural or man-made disasters. Disaster-oriented ERCS could be integrated with plans for further extensions of EMS to rural areas. In addition, as already indicated, they should be integrated with civil preparedness medical assistance plans for metropolitan areas.
6. The driving force in law enforcement support is the local law enforcement officer. His jurisdiction could extend into areas not covered by conventional communications, because he must be responsive to rapidly evolving, unpredictable occurrences.

2.3 VOLUNTEER ACTIVITY STATISTICAL DATA BASE*

Since any future system for improvement in emergency management decisions must start with the knowledge of the present state of the need, the answers to questions of: how many people get lost in the woods every year, or drown in floods, or are injured in tornadoes?, the building of a data base should be considered a national priority.

To answer these questions one would have to monitor the activities of 3,044 local law enforcement officers and an additional number of parish judges, fish and game wardens, state police officers, and other responsible organizations throughout the United States. In addition, it would be necessary to monitor the efforts of the multitude of volunteer organizations who provide much of the search and rescue manpower today.

In support of a future system, the National Association for Search and Rescue (NASAR), a non-profit teaching organization, is attempting to gather statistics from SAR and emergency response public safety organizations. NASAR is attempting to answer the fundamental questions of: 1) how many persons are in distress on the land areas of the country; and 2) how much national effort goes into their rescue and recovery.

One might ask, "Isn't that documentation already being collected?" After all, the Coast Guard counts the number of missions and man-hours spent saving people at sea. And searches for downed aircraft are tallied by the U.S. Air Force, the FAA, and the National Transportation Safety Board. The Coast Guard and U.S. Air Force form a central control point for the handling of boating and aircraft rescue statistics. But who controls a similar effort for land areas?

The answer is that no <u>one</u> organization oversees this important national endeavor: the saving of people who get into trouble without the use of a boat, airplane, or motor vehicle. Hard to believe, but in this age of computerized information gathering and data processing, there is nothing to help us document the size of the need of those people in distress on the land

* This contains excerpts from National Association for Search and Rescue, Report #3, dated December 30, 1978.

areas of the United States. In 1977 there were more than 37,000 disasters, according to the American National Red Cross figures, but there is no known figure recorded for the number of persons who were involved in those disaster situations. We can only estimate the potential figure by using such numbers as collected by the National Park Service, which estimates that over 50 million people participate in recreational activities on a typical summer weekend throughout the United States, with six million of these 50 million persons being in one of the National Parks each day.

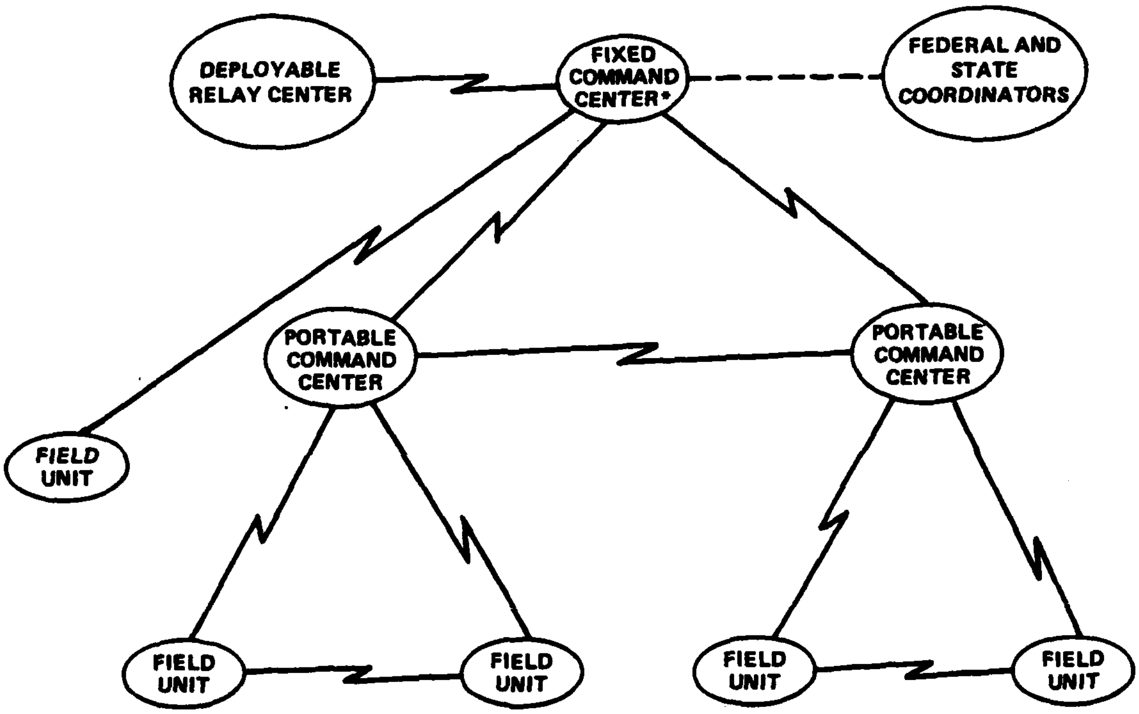
At present, the National Park Service has the most comprehensive system of semi-improved data collection and reporting. While data collection and statistical record gathering is a continuing effort of NASAR, it has met with limited success to date: 1) there is no mutually agreed upon standardization of definitions, categories, and methods for identification of information for land-based emergencies; and 2) the collection of such information is sometimes viewed as a threat by some agencies and organizations. Consequently, some are unwilling to part with their data, if they do collect any.

In addition, many of the emergency response efforts today are conducted by volunteers. This further complicates recordkeeping as there is no requirement for payroll or financial accountability. Furthermore, in the rush of the emergency, the last thought is the recording of data about those activities. Recordkeeping is attended to only after the fact, and then only if those involved can take time from their usual daily activities.

3.0 SYSTEM CRITERIA AND CHARACTERISTICS

The basic need is a communications system which can provide coverage throughout CONUS, Alaska, Hawaii, Puerto Rico and the Virgin Islands, and has the flexibility to meet communications requirements imposed by a diverse set of emergency response situations. Governmental agencies at all levels have expressed a need for a more universal and extensive communications network. Extension of existing terrestrial-based networks to all jurisdictions has been inhibited by economic, technical, and environmental considerations. Emergency assistance has also been hindered by lack of a simple, convenient method of interconnecting existing communications systems among jurisdictions.

Communications capability must be designed to support response to emergencies on a wide spectrum of severity. At the lowest level of severity, the response is on a one-to-one basis; e.g., the emergency could be a heart attack. At the intermediate level, severity introduces a need for coordination among the several groups rendering assistance; in this instance, the emergency could be a forest fire, flood, or downed aircraft. An emergency at the highest level of severity, which could be a major earthquake, nuclear accident, or even war, entails high volumes of traffic and necessitates coordination among the many groups and agencies providing assistance. In all cases, communications must be established between a coordinator and the field unit at the scene or scenes demanding the emergency response and often, communications must be established among field units. The basic structure of the communications system in shown in Figure 3.1.



*e.g., STATE EMERGENCY OPERATIONS CENTER (EOC), DEFENSE CIVIL PREPAREDNESS AGENCY (DCPA) REGIONAL CENTER, RESCUE COORDINATION CENTER (RCC), etc.

FIGURE 3.1. BASIC STRUCTURE OF AN EMERGENCY RESPONSE COMMUNICATIONS SYSTEM

While these examples demonstrate the generic need for response to all levels of emergencies, a more definitive examination entails delineating local, area, and regional needs, according to the governmental unit involved. Local needs typically involve agencies at the county level or below; area needs involve state governments or Federal agencies; and regional needs demand Federal Government response. As the level of emergency escalates, needs of the lower levels must be satisfied to maintain assistance in an extensive disaster situation. This section defines the system criteria that the working group has gleaned from its investigation and meetings with users.

3.1 SYSTEM CRITERIA

The following system performance criteria can be established to evaluate the performance of the ERCS:

- Availability
- Compatibility
- Selectivity
- Privacy
- Immunity
- Range
- Cost.

In the following subsections each criterion is defined and examples of user needs are presented to assist in clarification of the criteria.

3.1.1 Availability

The user requires 100% availability of the communications capability of the Emergency Response Communications System. This mandates that: (1) equipment distribution be widespread to ensure the presence of the equipment at the emergency scene within the desired response time, and (2) sufficient capacity exists to ensure delivery of the communications service. The Emergency Response Communications System must be available to as many users as possible—to anyone who may need it during an emergency or disaster situation. This need can only be served by a system which provides coverage, wide distribution of access terminals, adequate capacity, and flexible interconnections.

At the local emergency level, primarily at the county or parish level, the users will be law enforcement officers and providers of emergency medical services (EMS). Providing terminals to law enforcement officers and EMS providers in the nearly 4,000 counties of the United States would satisfy the basic equipment availability requirement. In an emergency requiring EMS, survival probability is a direct function of response time, as shown in Figure 3.2. This response time covers all phases (including alerting and identification of the emergency) that precede actual delivery of medical services. To function effectively at this level the ERCS must provide a mechanism to reduce response time in both the reporting-and-alerting phase and the supporting-and-transferring phase. The reporting-and-alerting phase starts when the need is perceived and ends when the emergency response unit arrives on the scene. For reporting and alerting, communication links are required among the scene of the emergency, the emergency response dispatcher, and possibly the emergency response unit itself (to provide direction). The supporting-and-transferring phase involves stabilizing the patient at the scene and en route to the site of definitive care. In the supporting-and-transferring phase a communication link is required between the EMS unit and the medical support facility.

Local law enforcement units are expected to generate most of the emergency reporting-and-alerting traffic and must therefore have nearly immediate access to the network. These units will also generate nonemergency traffic when using the system to extend the coverage into areas where terrestrial service is not available. This traffic involves relatively short communications between field units or from a field unit to a control center.

At the area level the primary users are the state Emergency Operations Centers (EOC), Rescue Coordination Centers (RCC) and Defense Civil Preparedness Agency Regional Coordination Centers. Which command center is responsible for an area-level disaster depends on the type and size of the disaster. Equipment required to support a command center consists of expanded or additional communication channels for coordination activities. Each state and participating Federal agency is considered to be a command center,* making a total of nearly seventy-five such centers in the country. When a command center is activated,

*Some of the Federal agencies may have more than one.

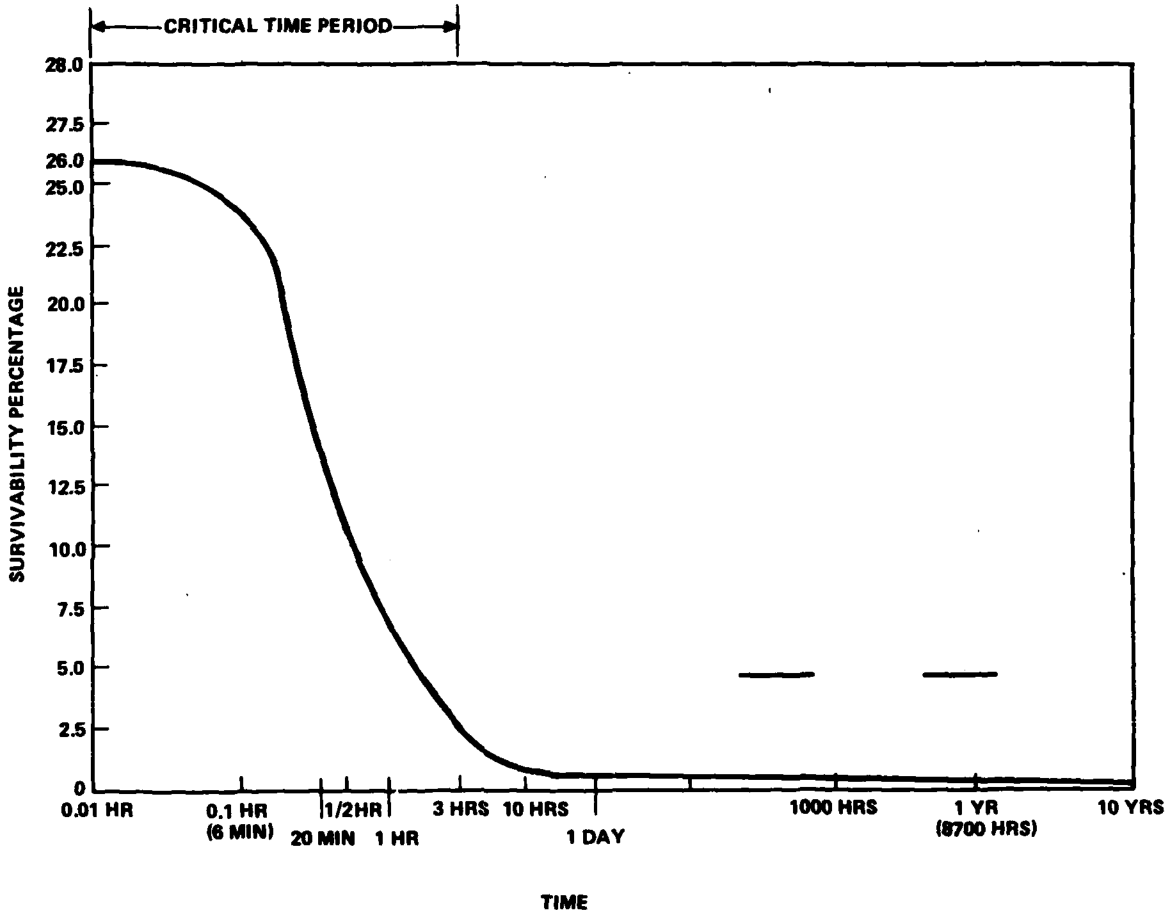


FIGURE 3.2. PROBABILITY OF SURVIVAL AS A FUNCTION OF TIME BETWEEN INJURY AND PROPER MEDICAL TREATMENT

additional field equipment will be deployed to the scene with the objective of reaching operational status at the scene of the disaster within 2-4 hours. This field equipment must be capable of supporting the emergency response mission without external power sources for up to 48 hours.

Each command center must be capable of conducting simultaneous conversations on each of its assigned channels. When not required in an emergency this capability could be used to support reporting-and-assignment traffic to field units that might not be able to use existing networks.

At the regional level, the primary users are Federal agencies committed by the President; hence additional requirements would include facsimile, teleconferencing communications, and other various services. The number of users and the complexity of equipment needed to meet this requirement implies that only a few transportable terminals will be required nationally. Operation of these wideband transportable terminals at the emergency site within 12 hours or less after notification should satisfy this basic availability requirement. These terminals must be self-powered and capable of operation for an extended period.

The traffic generated at both the area and regional levels is expected to be very heavy during an emergency situation. In such cases the system design must meet a peak load rather than a statistical average. At the regional level, the Defense Civil Preparedness Agency has an initial load estimate equivalent to one wideband channel. At the area level, a peak-load estimate of 5 narrowband channels for each state and Federal agency has been used.

3.1.2 Compatibility

The ERCS must operate with existing communication systems, expanding the total communications capability for each user to meet his emergency response needs. The ERCS will become an extension of existing communication capabilities; therefore, it must be technically and operationally compatible with existing systems.

An emergency operation that calls for the participation of several groups or agencies such as public service, volunteer and/or military organizations might involve the use of different communications systems. More often than not, the systems in use are not compatible with each other (e.g., frequency

modulation, service). This means that the different groups of the emergency response team are unable to communicate with one another. The inability of a sheriff's ground-search crew to communicate with a National Guard aircraft is an example of today's incompatibilities.

A communications system intended to facilitate coordination between different emergency response groups should ideally link various incompatible systems in use; that is, it should allow different systems to communicate with each other. At the same time, the system should not reduce or duplicate the capabilities of any existing systems with which it works; it should augment the existing systems.

The ERCS must be compatible with existing systems in order to increase their range and availability and capitalize on existing management structures within the organizations and agencies. This compatibility implies the ability to communicate with a terminal of the ERCS from a terminal of an existing system. Likewise, existing system users should be accessible from a terminal of the ERCS. The addition of this capability must not, however, diminish the capacity of the existing system.

3.1.3 Selectivity

The communications function of an ERCS must be assignable on the basis of need. Field units must be connected to EOC/RCC and interconnected at the scene, and it must be possible to develop a network consisting of field units, base facilities, and multiple EOC/RCCs. A chart showing Search and Rescue Request and Communication Channels is presented in Figure 3.3. This chart illustrates the communications channels required to support a disaster and request assistance. A more general view of the interconnection problem is given in Figure 3.4, which shows the Search and Rescue (SAR) interconnection requirement. A primary requirement will be incorporation of central direction and control from primary and subordinate control points to sort out and direct emergency response.

A requirement exists to interconnect any set of ERCS terminals on an ad hoc basis to form one or more networks devoted to a specific function. A requirement also exists to prioritize channel usage and to control access to a dedicated channel. A major forest fire would be a good example. Typically, two or three separate teams will be involved at different locations. Each

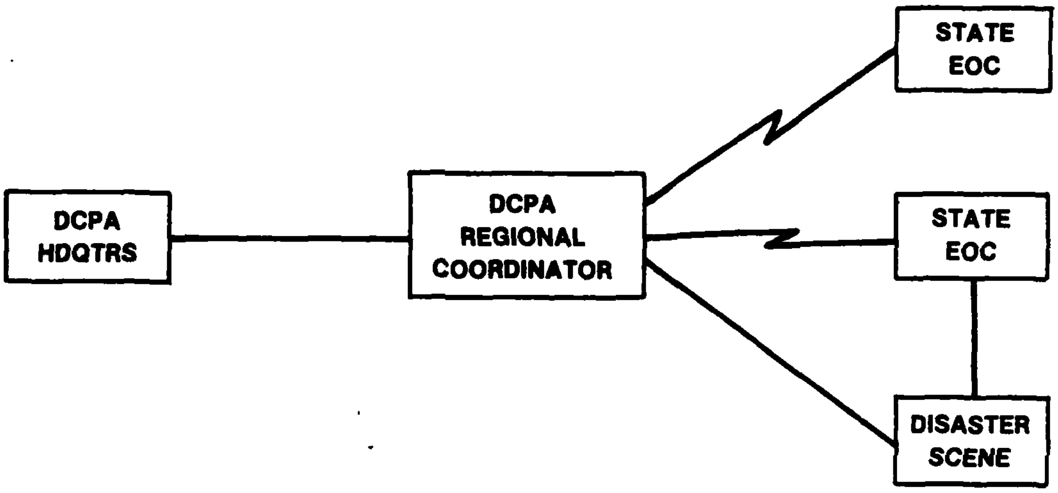
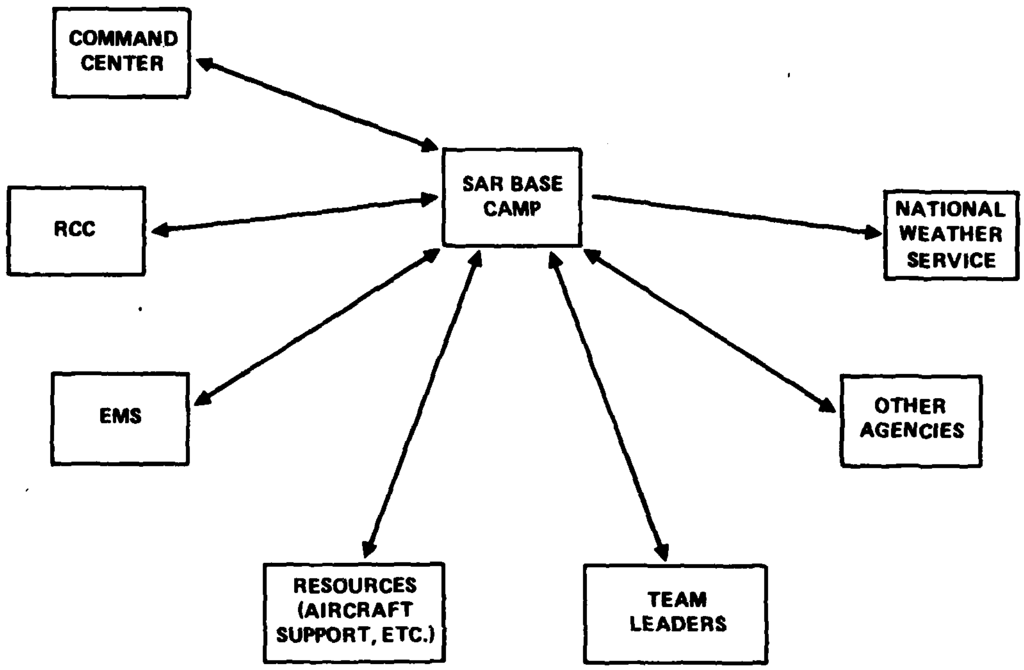


FIGURE 3.3. TYPICAL INTERCONNECTIVITY BETWEEN DCPA, EOC, AND DISASTER SCENE



REQUIREMENTS

1. **EXCLUSIVE COMMUNICATIONS WITH VARIOUS UNITS.**
2. **COMMON ALERT FREQUENCY WITH THOSE UNDER COMMAND OF SAR BASE CAMP.** ***(MAY UTILIZE "PAGE-BOY" SYSTEMS, ETC.)***

FIGURE 3.4. TYPICAL INTERCONNECTIVITY REQUIRED BY AN SAR BASE CAMPLEADER

team could utilize aerial support on a spot basis. The ERCS must generate a separate network for each team that could include the aircraft. A local team leader and the fire-fighting base camp could be interconnected with or without the actual fire-fighting team. By expediting reports and decisions, ERCS can directly support the fire-fighting effort.

3.1.4 Privacy

There are two aspects to the privacy criterion: one is exclusive use of the assigned channels and the second is the protection of the information in the user's message.

Each of the users must be assured exclusive use of his channels; this requires that each user group have control of its portion of the system. This control will preclude inadvertent interception of traffic in the network. Communications between a local sheriff and his control center, or between ambulances and hospitals, etc., will not be accessible to other terminals.

In addition to providing user control and preventing inadvertent interception, the ERCS must be designed to allow users to use commercially available scramblers and/or crypto-security if their mission has the need. Examples are protection of patient data and protected transmissions for law enforcement agencies.

3.1.5 Immunity

The immunity criterion, like privacy, had different meanings to the user community. Immunity for the ERCS has three parts as discussed in the following sections.

The system must be immune to a loss of communication capacity as a result of an emergency, environmental condition, or loading condition. Implicit requirements for an emergency communication system are that the components be reliable, the system self-contained, and operational capability of the system independent of external factors. Many of the communication systems in use by the emergency response community are dependent in part on terrestrial facilities. Destruction of these or interconnecting facilities or loss of power reduces communications capability. The terminals in the ERCS must be self-powered and the system must be capable of reconfiguration so that any of its nodes may be bypassed.

AD-A080 758 INTERAGENCY COMMITTEE FOR SEARCH AND RESCUE WASHINGTON DC F/G 17/2.1
EMERGENCY RESPONSE COMMUNICATIONS PROGRAM.(U)
JUN 79

UNCLASSIFIED NL

2 OF 2
AD A
080758

END
DATE
FILMED
3 — 80
DDC

A major consideration in development of an ERCS is immunity to external noise and interference. The propagation medium has a direct bearing on these factors. Existing public safety frequency assignments below 50 MHz are subject to interference and noise generated at long distances from sky wave reflections by the ionosphere. Since long distance communication at these frequencies also depends on these reflections, it is erratic and requires a periodic change of frequencies to maintain communication. Public safety assignments between 150-500 MHz permit line-of-sight (LOS) operation, thus reducing noise and limiting interference sources but restricting operational range. The environmental considerations in this band are the effects of nearby lightning and urban noise temperature. These factors are important only insofar as technology has permitted development of more sensitive receivers. The next major environmental constraint appears at frequencies above 10 GHz, where rain increases the atmospheric loss, resulting in outages.

Immunity from system loading requires a system design which can accommodate the maximum loading expected. Permitting use of the system by random users would result in an overload during emergencies that would block needed access. Therefore, the system must include a means of setting priorities and a means of switching channel capacity to the desired user.

3.1.6 Range

The system must provide full capacity in any physical situation. The expected system usage suggests that separation between the nodes can range from a few miles to the breadth of the country. Existing communications systems provide a local coverage area, generally with blind spots. Extension of coverage and removal of blind spots require a significant capital investment in terrestrial facilities. The ERCS system design must provide coverage independent of local geographical conditions. Direct point-to-point communications between any set of nodes in the system require terminal facilities comparable in power and design to radio units currently in use by public safety personnel. The system must provide this extended coverage at significantly less per capita cost than existing terrestrial systems that service the more populated regions of this country.

3.1.7 Cost

The system must be affordable to the subscribers (Federal, state, and other organizations). This requires extensive cost analysis of not only the system components, but its operation, maintenance, and benefit.

3.2 SYSTEM CHARACTERISTICS

The foregoing criteria lead to a preliminary system configuration which has the following features:

3.2.1 Types of Service

The greatest need is centered on services which can be handled by narrow-band channels. These services include voice communication, data transmission and medical telemetry. Rapid response time is required in the majority of uses, therefore the user community must be widely dispersed geographically. The localized nature of the basic services suggests that the communications needs will be regional in nature, probably based on county. The usage pattern for this narrowband service is short duration communications.[1]

A lower volume exists for services which require a wideband channel. These services include teleconferencing, high-speed data transmission, and slow scan television. Response time is not a major consideration and the user community is small. The usage pattern is expected to be erratic, two to three days, several times a year, with only minimal application at other times.

3.2.2 Network Configurations

To meet the system criteria, a variety of networks are required, and the system must be capable of creating new networks in real time using the existing user equipment. The basic set of networks to be developed is:

- Point-to-Point
- Point-to-Multipoint
- Multipoint-to-Point.

The inherent flexibility required in the ERCS suggests the need for a comprehensive planning document similar to the existing National Communications

---

[1] An estimate of 0.03 Erlangs (1.8 call-minutes per hour) is suggested for law enforcement users based on experience with other communication networks and based on available EMS data.

System Plan for communications support in emergencies. This plan would define the criteria and authority for allocation of ERCS capabilities in a major disaster situation. The basic networks are shown schematically in Figure 3.5.

3.2.2.1 Narrowband Networks. Each of the system subscribers requires access control to the network(s) he establishes for routine use. In an emergency, however, these networks may require expansion in both capacity and user equipment. This set of conflicting requirements leads to a central system control which can sort out conflicting requirements in real time and meet the most urgent system demands. One element of the system is the protocol by which the subscribers operate through a system control center.

Potential subscribers have described preliminary network arrangements. Massachusetts, for example, requires an Emergency Operating Center (EOC) and eight user terminals for civil defense purposes. The U.S. Postal Service requires a tie between Postal Service Headquarters and seven regional locations. Additional channels are required between five regional headquarters facilities and subordinate major mail handling facilities. California, the U.S. Air Force, and the U.S. Forest Service all have indicated needs for communications between support units, such as aircraft, and disaster relief teams, such as search and rescue teams, forest fire fighters and emergency medical teams.

The number of unique networks to be generated has not been established with any degree of confidence; however, based on the service types, it appears that a baseline system will provide a point-to-point network for both EMS and law enforcement agencies, thus providing at least four terminals per county.

Independent operation of each network is mandatory at most times; however, interconnection must be accomplished on a demand basis when the services become mutually supportive. If we further assume this supportive type of service which will be the bulk of normal traffic, is most needed in rural counties, eatimates of terminals and loading can be obtained. A recent study of Appalachian states showed 124 counties out of 403 (31%) had populations less than 15,000. These are representative of the rural communities most in need of routine services expansion. For planning purposes, two emergency communications networks of 2 terminals each are assigned to each of 1,300 counties and

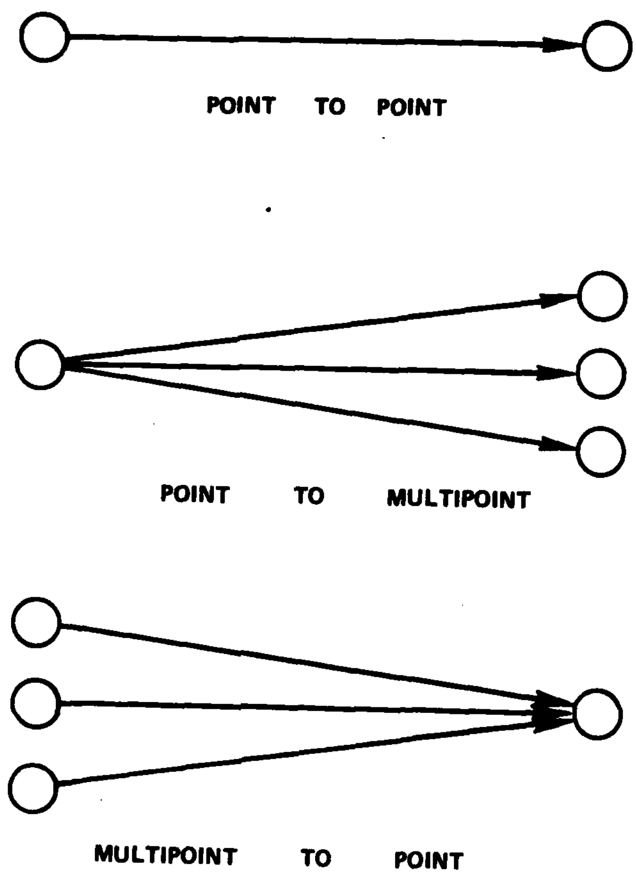


FIGURE 3.5. BASIC NETWORK CONFIGURATIONS FOR AN EMERGENCY RESPONSE COMMUNICATIONS SYSTEM

one network to each of the remaining counties. One network consisting of EOC and 5 portable terminals is assigned to each state and Federal agency.

3.2.2.2 Wideband Network. Since there will be fewer wideband channels due to higher cost and lower demand, these wideband channels will necessitate a higher level of coordination. Users of the wideband network will obtain authorization prior to any operations. Both the number of terminals and access time will be under direct control of the operating agency. Thus, the ERCS must only provide adequate capacity between specified terminal locations. Both expected usage patterns and control lead to an on-demand requirement with evaluation of long-term usage required to establish the channel requirements and usage configuration.

3.2.3 User Terminals

A variety of user terminals are required in developing the required networks. These terminals are described in the following sections:

a. Field unit: a small portable unit capable of transmitting and receiving voice or data on a narrowband channel. The system could initially contain between 10,000 and 15,000 units.

b. Portable command center: a portable unit capable of transmitting voice or data on five narrowband channels simultaneously. The unit is portable in the sense that one person can transport it to a remote location and put it in operation. The system could have approximately 100 of these units.

c. Deployable relay center: a portable unit capable of transmitting and receiving one wideband channel. The unit is portable by means of a truck or aircraft to a remote location. The system could contain 25-35 of these units.

d. Fixed command center: an installation capable of transmitting and receiving multiple narrowband and/or wideband channels. The system will contain approximately 100 of these installations, each designed specifically to satisfy the coordination function.

e. System control center: a fixed installation that provides control, housekeeping, and administrative functions.

4.0 CONCEPTUAL SYSTEM DESCRIPTION

4.1 OPERATIONAL CONCEPT

The system design must provide a high degree of operational flexibility to accommodate the wide variety of circumstances in which it will be used. This flexibility will be afforded by establishment of protocols and priorities that govern lines of authority and the working relationships among the user communities. The responsibility for establishing these protocols and priorities will be the User Steering Groups. There will be two levels of protocol and prioritization. The first level will be among the users of the service (the agencies and the states, for example); the second level will be within the user's organization agency and state to maintain his control. The users will establish their own control protocol and prioritization. This flexibility allows each user to devise the access controls on its allocated capacity in the way that best reflects its need. Capacity allocation is in terms of operating channels, each of which can carry the required signal format.

Another significant feature of the system operational concept is exclusivity of access provided each user. If a user is allotted five channels, then, barring a national emergency, those five channels will always be available, regardless of the channel usage elsewhere in the system. This exclusivity may be exercised at lower levels within the user's domain. For example, a channel could be reserved for exclusive use by the state highway

patrol, or a particular county sheriff's department, if the state considers it desirable. This design of the system allows the user having exclusive use of a channel to establish priorities and protocols it deems most appropriate for the use of its channel.

4.1.1 Channel Access Control

The technique of controlling access to the system's communication channels is similar to that proposed for a multiservice land mobile radio system by the Association of Public Service Communications Officers (APCO). The operation of that system is described in the APCO report on Project 16, dated January 30, 1979. The APCO system is a terrestrial system intended to provide total mobile communications to all public service agencies within a municipality. The application is similar to that of the Emergency Response Communications System and the control scheme is easily adapted.

Access control is based on the ability of a central controller (a switched logic device located in the relay station) to evaluate a request and designate transmit-receive channels. Designation of operating channels is accomplished using a control channel that has been set aside for this purpose. The assignment is based on the actions of terminal operators (or a central operator) and a set of predetermined protocols. The controller establishes circuits between terminals by directing the terminals to switch to a compatible set of channels. Controller operation is normally automatic, but a manual override operation capability will be provided to establish special networks and assign special priorities.

Each terminal capable of operating within the system will have a unique address that essentially can be thought of as a telephone number. The controller can send messages (digitally encoded) to a particular terminal via the control channels by means of this address. The terminal can also send messages to the controller and identify itself with its address. These messages include channel access requests from the terminal to the controller and channel designation commands from the switch logic to the terminals.

The basic steps of system operation shown in Figure 4.1 are as follows:

- A terminal operator enters the address of the terminal with which he wishes to communicate on a keypad. The address may contain a priority level, and if a higher priority level is required, it may be requested.
- The terminal sends a channel access request message to the controller on the forward link control channel frequency, f_0 (see Figure 4.1.a).
- The controller receives and decodes the called-terminal address, priority, and calling terminal address.
- The controller determines, according to its stored access values, whether the calling terminal is allowed access to the terminal called.
- The controller identifies a pair of idle channels (e.g., return link frequencies f_2 and f_3, forward link frequencies f_4 and f_5) and sends both terminals channel assignment messages using the return link control frequency f_1 (see Figure 4.1.b).
- A switch in the relay station connects forward link channels at frequencies f_4 and f_5 to return link channels at frequencies f_3 and f_2, respectively. The terminals meanwhile switch to the designated transmit and receive frequencies, and a duplex circuit is established (see Figure 4.1.c).
- A network of several terminals is established by a central operator, who upon request sends the same channel assignment message to all terminals included in the network. This gives all the terminals the same transmit and receive channels so that each terminal receives and is received by all others on the same frequency.
- Channel assignments to a pair of terminals remain in effect until released by a sign-off signal from one of the terminals. A terminal automatically reverts to the control channel frequency when its assignment is released.

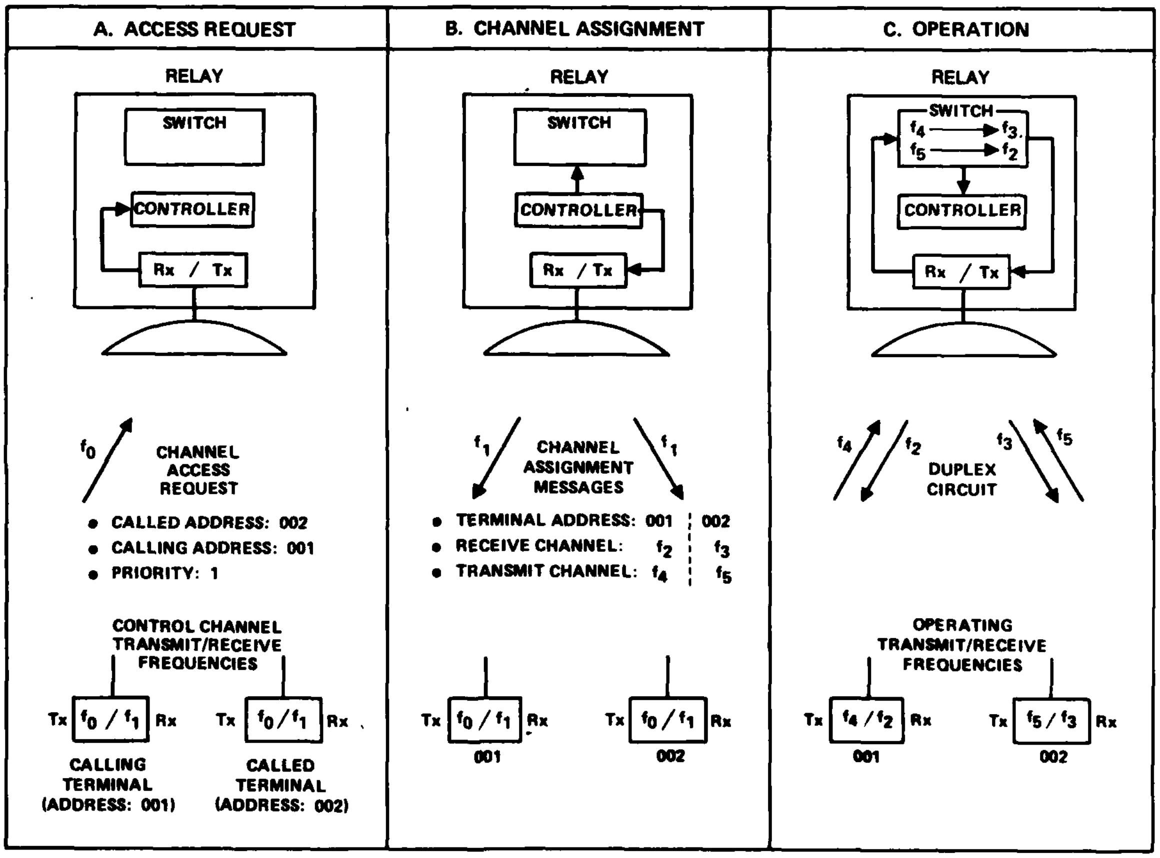


FIGURE 4.1. BASIC STEPS OF SYSTEM OPERATION

Priorities are introduced when the controller receives a valid access request but finds that all the available channels have been assigned. The controller may pre-empt channels in use when this occurs, in accordance with the procedures established by each user group or between user groups.

4.1.2 Priorities and Pre-emption

The system guarantees the availability of a certain number of channels to the user. However, it is generally expected that the number of channels available would be time-shared among a large number of terminals, which means that requests for channel access will be received at times when there are no idle channels available. A ranking of priorities established by protocol is provided to resolve the potential conflict.

The capability of pre-empting a channel on the basis of priorities is a unique feature of the system to ensure that channels will be immediately available for highly urgent communications. This feature is especially important for a system intended for emergency response. Given this intent, a majority of requests for service will have some degree of urgency. The priority assigned to an access request quantifies the degree of urgency so that contending demands on the system may be compared and the most urgent demand given access.

A priority is normally selected for a call by the originating terminal at the time the call is made. This may be implemented in the address or in a special key, or both. The priority levels to be used are defined by each user and the selection is based on the judgment of the operator. Allowing the operators to select priorities will demand discipline on their part, which may be enforced by using channel logs that can be automatically maintained by the controller.

A priority level may be assigned to a channel manually by a controller operator. This method is used to associate a priority level to a network of several terminals using the same set of channels.

The specification of the various levels of priority is a function of the users. This priority allocation only affects those channels assigned to each user. The priority criteria are maintained in the controller. Here is a possible list of priorities given for illustration:

1. Routine and administrative communications
2. Command and control associated with emergency operations
3. Distress—life in jeopardy
4. Life-saving operation in progress
5. Special priority (assignable by controller operator only).

4.1.3 Interfaces with Terrestrial Networks

Terminals using the ERCS will interconnect with tariffed services and/or terrestrial networks, including the public telephone and public service mobile radio and private safety networks. Interconnection with terrestrial networks is accomplished on a local basis through an interface unit and normally will be performed at a control terminal. For an existing radio network this is essentially an ERCS terminal and a radio transceiver connected at baseband. In addition to providing interconnection between systems, this interface unit adapts the full duplex operation of the ERCS system to the simplex and/or duplex nature of the existing radio system.

Interconnection of the Emergency Response Communications System with telephone systems is accomplished with another type of interface unit at the control terminal. In this case the ERCS terminal is connected at baseband to telephone lines. This interface, besides providing an electrical connection to the telephone circuit, inserts supervisory signals (i.e., on-hook/off-hook indication). The telephone interconnection would normally be into a manual PBX (private branch exchange) of the user's offices. Interface with automatic PBX systems is also possible.

4.1.4 Implementation of Access Controls

The users will determine the best ways to implement their access controls. They will do this by assigning terminal and channel access protocol.

The controller may be programmed to allow each terminal to communicate with only a specified group of other terminals. The accessible group for a particular terminal would normally include terminals belonging to the user group and to certain other organizations with which emergency communications may be required. Thus, a sheriff's terminal might be given access to municipal police and fire departments in the county, the state police, and Federal agencies

with jurisdiction within the county. The sheriff's department would probably not, however, be provided access to terminals of other state agencies.

The controller provides for selectively restricted access to channels as well as terminals. This is the mechanism used to reserve a set of channels for exclusive use by a user. Channel access restriction is accomplished by making a segment of each terminal's address unique to the user group to which the terminal belongs. The controller "knows" the number of channels allotted to each state or agency, and by means of these unique address segments it is able to keep a count of the allotted channels in use. When the count equals the allotted number, the controller satisfied new channel requests by pre-emption of channels in accordance with the user's established protocol. Only those channels being used by terminals within the same user group are candidates for pre-emption.

A user group may elect to set aside one or more of its channels for special use. Such a subdivision of channels is easily accommodated by addressing. The user that is given an exclusive channel is assigned a unique address; thus, when this address is involved in a call, a top priority is assigned.

4.1.5 System Control Centers

The channel access controls are actually implemented at one of the system control centers, from which the relay station controller is activated. There will be more than one system control center for the Emergency Response Communications System to assure survivability of the ground portion of the system. The number of control centers will be determined by the Operating Agency and the contractor to meet overall system survivability requirements. The control center is the single control point for the relay portion of the system. The users, through the User Steering Group, will formulate channel and terminal access protocol and procedures, and implement these at the control center. These instructions govern the automatic functioning of the system from the time they are inserted into the controller. No further action by the control center is necessary unless the user requests changes in the rules or manual operation.

Manual operations that are possible from the system control center include invoking a special priority, making special interconnections, and creating special networks. Special interconnections constitute temporary changes to the terminal access rules; they allow communication between terminals that do not normally have access to one another according to the established protocol. Special interconnections are possible between any two terminals in the system, and could be extended among user groups. These interconnections are made upon a request from a designated authority, such as NCS. An interstate/interagency special interconnection is made in response to a joint request by the user groups.

The control center creates a network by connecting three or more terminals to a single pair of channels. This places the terminals on a "party line," allowing each of them to receive any of the others and to transmit to all the others simultaneously. Such a network would be required to support such extended operations as searches or forest fires, where several responding units must coordinate their activities.

The relationship between the system control center(s) and the users of the system is shown in Figure 4.2. In addition to the single operational control center, there are one or two diversely sited back-up centers to ensure operational survivability of the ground portion of the system. The control center has access to the controller in the relay.

The system control center is linked to approximately 70 points of contact, one for each user group. These points of contact are normally the emergency coordination centers for operations within the state or agency. Each EOC or RCC has simultaneous access to all its channels and is at all times appraised of the communications requirements of the users within its jurisdiction. Requests for manual operations, including special interconnections and networks, are generated by the control terminal to support emergencies. The control terminal also advises the system control center of changes required to the normal access rules for its channels, so that the controller can be updated.

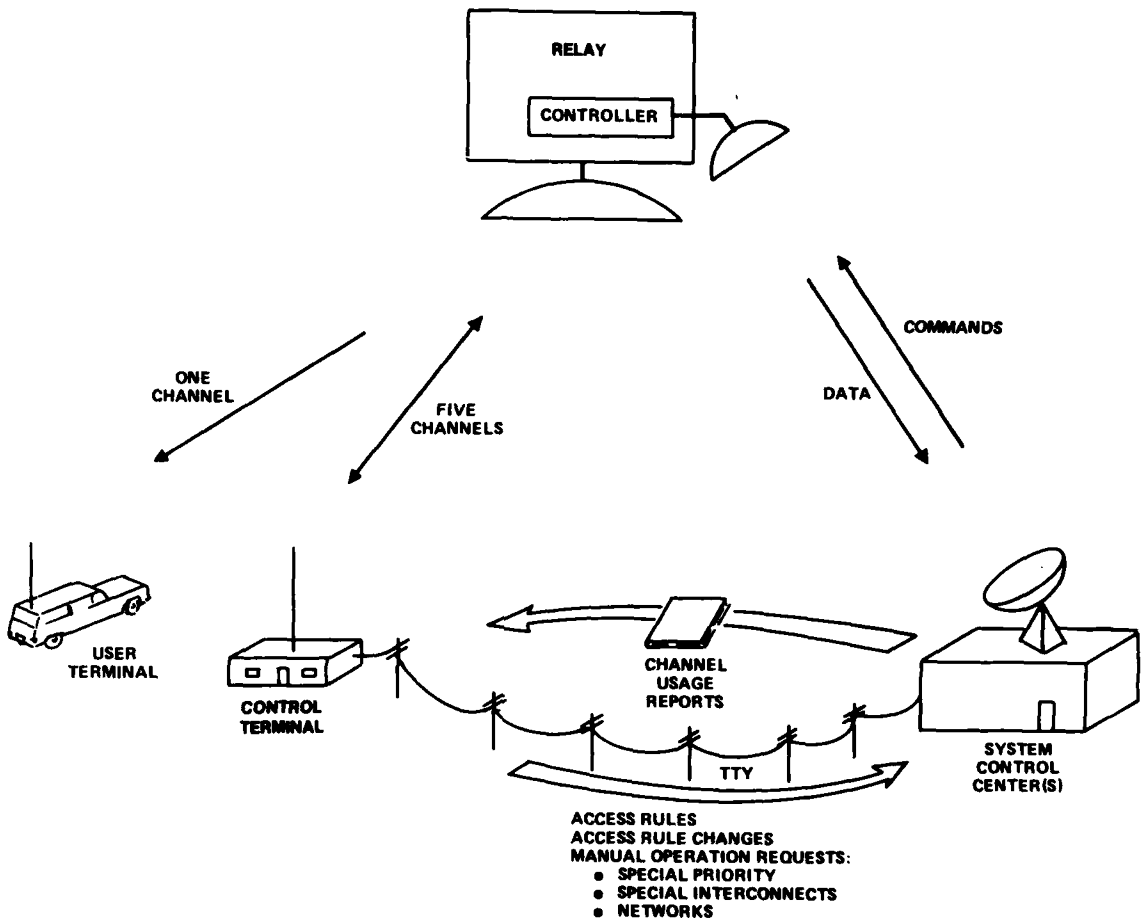


FIGURE 4.2. RELATIONSHIP BETWEEN SYSTEM CONTROL CENTER(S), CONTROL TERMINAL AND USER TERMINAL

The system control center performs both administrative and operational functions. It produces reports of channel usage for each user which could detail a complete user history over a period, including calling and called address and priorities, or they could simply give, say, the number of calls at each level of priority.

4.2 CONCEPTUAL SYSTEM DESIGN

In developing an ERCS concept, both current communications capability and future technological advances must be considered to assure that the user criteria are satisfied at a realistic user cost. Extending communications capabilities for public safety usage is currently part of the capital improvement program in many of the political jurisdictions which have contributed to this report. Nevada is presently constructing a microwave system to improve communications capability. In Mississippi, EMS services have been extended in both the Hattiesburg area and the Arcadian region through new radio relay installations. A common set of radio frequencies is used by the Rochester regional medical program, which extends over ten counties in central New York.

4.2.1 Current System Constraints

All known public safety communication systems are characterized by assignment of specific radio frequencies for each channel to each public service agency. Terminals are generally set for a specific set of operating frequencies, thus inhibiting their use in other networks. Expansion of the system capacity during an emergency is virtually impossible due to lack of flexibility in the physical plant and regulations which define the usable frequencies in any region. A factor of major concern in any planned expansion of these networks is the lack of sufficient frequencies to meet the total demand. Increasing the number of available channels through improvements in spectral efficiency has been the subject of numerous studies[1,2,3] related to public safety considerations and the more general communications

---

[1] Expansion of Land Mobile Cellular Service by Communications Satellite ORI Draft Report, May 1979.

[2] A Study of Land Mobile Spectrum Utilization, Stanford Research Institute.

[3] The Application of the 900 MHz Band to Law Enforcement Communications, prepared by APSCO for LEAA.

problem. Improvements in spectral utilization through better filters and more stable radio designs are becoming less cost effective as we approach optimum capability in this single channel access system design.

4.2.2 ERCS Architecture

In recent years the concept of trunked systems for public safety communications systems has been the subject of investigation. In a proceeding titled "An Inquiry Relative to the Future Use of the Frequency Band 806-960 MHz," the Federal Communications Commission took steps to open a major segment of the radio spectrum to public safety communications systems and other members of the land mobile community. In this new spectrum allocation the Commission determined to require innovative engineering techniques and methods of frequency assignment among radio systems as well as to continue some features of established technology and spectrum management systems. To meet these objectives, the Commission encouraged use of "trunked" or computer-switched technology in which many users can share a number of frequencies by use of computer controlled channel switching. In an APCO study (called Project 16) under an LEAA grant, it was determined that use of these 900 MHz frequencies presents a new opportunity for the law enforcement agencies to upgrade their services. In fact, LEAA is planning a demonstration program to evaluate the applicability of both the frequency band and the trunked system concept in public safety services. In recent years, ATT has developed and tested an Advanced Mobile Phone Service in the 900 MHz band based on this trunking concept utilizing computer controlled switching.

Some appreciation of the trunked system's advantages can be seen in Figure 4.3, which shows the probability of blocked communication for any user in a community as a function of the number of available channels. The spectral efficiency achieved by serving a large user population is clearly demonstrated. Present applications of the trunked system concept have concentrated on high population density areas where the user population can be obtained within line-of-sight distance from the base station antenna. In the ERCS, the total user population is only 10,000 to 15,000, spread over CONUS, Alaska, and Hawaii. Achievement of a user population in excess of 200 in one region requires a system which divides CONUS into about 50 regions,

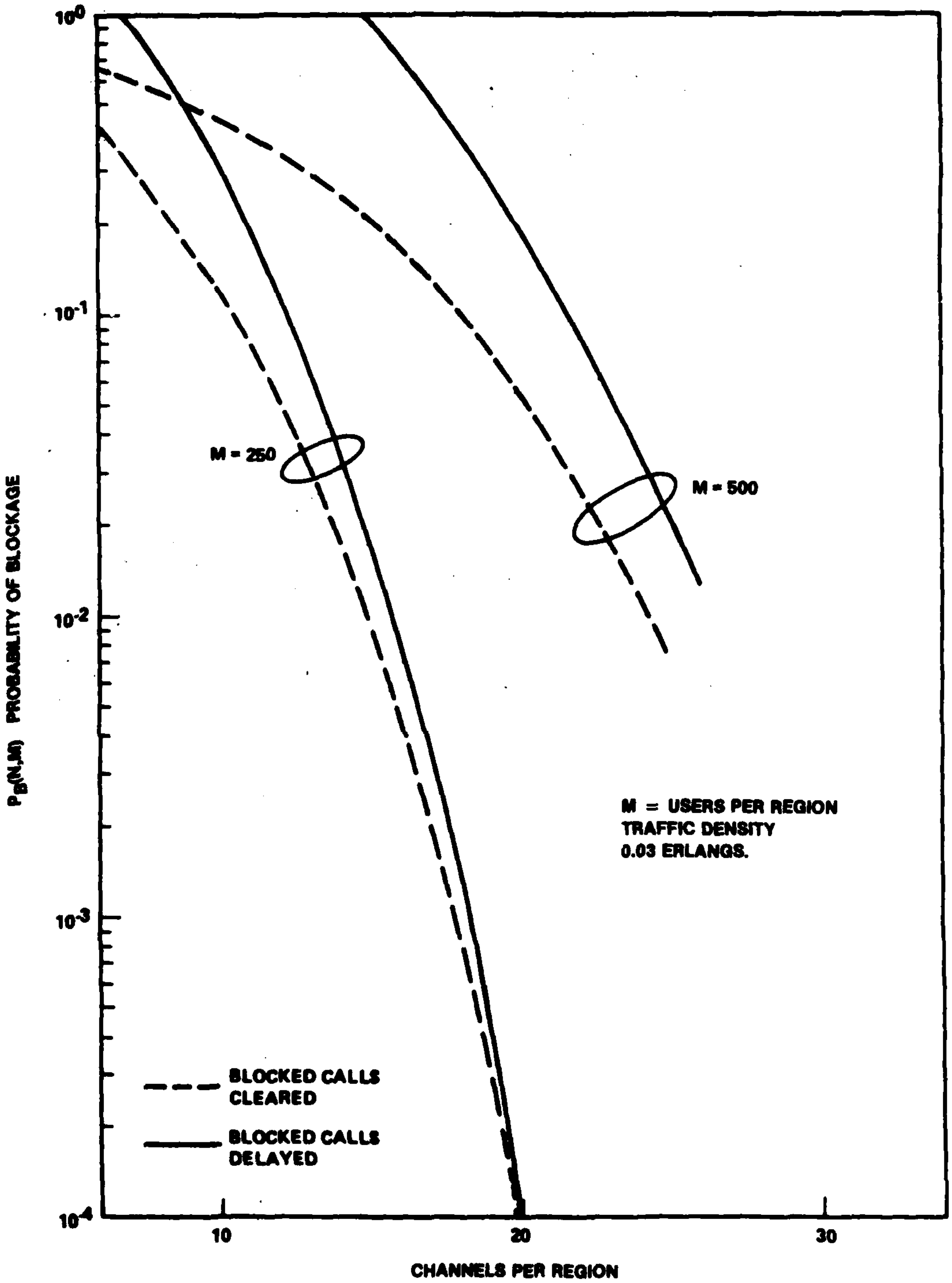


FIGURE 4.3. EXPECTED NUMBER OF CHANNELS AS FUNCTION OF PROBABILITY OF BLOCKING THE CALL

each region under control of a central computer. This user population would require ten channels to achieve less than 10% blockage at the assumed traffic density.

Use of a trunked system design clearly satisfies the basic ERCS needs of flexibility, access, and interconnectability.

4.3 SYSTEM IMPLEMENTATION

It is clearly beyond the function of this report to describe a system design in detail; however, in evaluating the system concept it is convenient to consider a potential design approach. To satisfy the user needs, the ERCS must possess the following characteristics:

- No line-of-sight limits
- Long range
- Mobility, Portability
- Flexibility capacity
- Low cost.

Table 4.1 compares these characteristics with several communication techniques. The telephone system is basically a wire-based terrestrial system which uses microwave links in the network. The HF, VHF, and Tropospheric radio systems are point-to-point links which can interface to terrestrial systems at both terminations. These systems are generally familiar to the public safety user in both form and operation; therefore, no further description is deemed necessary. These systems all exhibit one or more serious deficiencies when evaluated against ERCS needs.

Another characteristic of existing terrestrial systems pointed out by the Associated Public Safety Communications Officers, Inc. (APCO) before the FCC in March 1978, is that the common denominator in most disasters is:

> "the failure of all local communications systems for some period of time, primarily because local electric power systems failed and wire line telephone links for local radio systems were incapacitated along with the common carrier networks. Normally, the only local with emergency power or VHF systems which do not have the capacity to cover the distances. . . . . are often dependent on wire line control links."

Thus, without equipment to support a mission, it is not even possible to modify the mission operational plans to accommodate these deficiencies. A communications system, based on the use of satellites as the relay station, appears to be a viable alternative which satisfies more of the desired ERCS characteristics than any other communications technique. To assist the reader, a brief description of a viable satellite-based system implementation for ERCS has been included in this report.

4.3.1 Satellite System Concept

Numerous studies have examined the potential application of satellite technology to meet public safety and mobile communications requirements.[1,2,3] In these studies a communications satellite is located at geosynchronous altitude to provide coverage of CONUS, Alaska, Hawaii, Puerto Rico, and the Virgin Islands. In the ERCS application the communications payload would provide a single wideband channel for multiplexed narrowband circuits, video or high-speed data traffic. The payload would also provide approximately 550 narrowband channels to provide point-to-point communications for approximately 20,000 users. On-board automatic switching provides the capability of interconnecting any pair of narrowband channels. The design incorporates a multibeam antenna to facilitate frequency reuse for spectrum efficiency and to maximize signal power to each user.

4.3.2 Satellite Design

A relatively large satellite is required to support the electronics package and the multibeam antenna. Location of this satellite near 130°W long. at geosynchronous altitude permits coverage of CONUS, Alaska, Puerto Rico, Hawaii, and the Virgin Islands with a set of spot beams. A conceptual drawing for this type of satellite is shown in Figure 4.4. The large reflector is used to generate the single beam required for wideband coverage of CONUS. Wideband communications to the non-CONUS areas would utilize spot beams formed by portions of the large reflector.

---

[1] Mobile Multiple Access Study, TRW Defense and Space Systems, August 1977.

[2] Technology Requirements for Post-1985 Communications Satellites, Lockheed Missiles & Space Company, October 1973.

[3] Satellite Systems for Extended Range Coverage - Applications in Law Enforcement, J. Parness, Mitre Corporation.

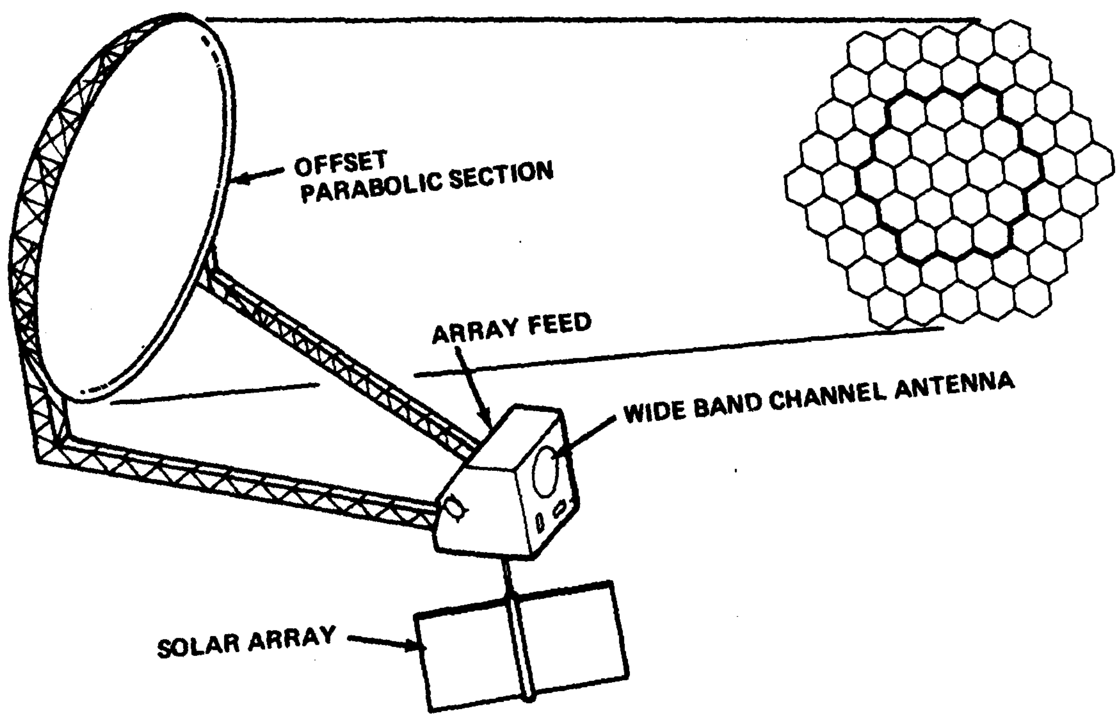


FIGURE 4.4. CONCEPTUAL SATELLITE DESIGN

4.3.2.1 Capacity. In a trunked system both the spatial and frequency domain are utilized to generate the required channels. In the spatial domain separate beams with frequency reuse of 4:1 generate 550 SCPC narrowband channels to meet system requirements. The SCPC channels will be shared by the entire community, thus generating a potential peak load in excess of design capacity. A design which satisfies economic constraints realistically presupposes a system that is accessed by only a small number of users in any given time frame. In this system concept each beam contains 10 channels, allowing any user access to one of 10 channels. Thus, the system can meet any user requirement with only 40 channels of assigned bandwidth. With the user population uniformly distributed, say, 200 to 400 per beam, and an assumed usage factor of 0.03 Erlangs, the probability of obtaining a channel is approximately 90%. Access control, through software, is used to provide channels and establish priorities. Implementation of this design requires a determination of the actual usage factors and generation of protocols for the user community.

Each wideband channel will operate at one frequency and must be assigned to the user. This channel will provide high speed data, multiplexed narrowband channels, and/or slow scan video. The space segment provides a transponder to accommodate this traffic.

4.3.2.2 Coverage. The narrowband service to CONUS is provided through 50 overlapping spot beams. Each beam is approximately 0.7 degrees and covers a 360-mile diameter circle on the earth. The spatial separation of the coverage areas permits reuse of frequencies on a non-interfering basis. Studies have shown that a 4:1 frequency reuse factor is near optimum; thus the total spectral requirement is four times that required for any single beam. The user location is derived through information acquired from the control channel in each beam. This channel provides the address for each user in addition to carrying the system control information.

The wideband service is provided through an elliptical beam covering CONUS and spot beams for Alaska, Hawaii, Puerto Rico, and the Virgin Islands. Each beam carries the same traffic, effectively placing the total area into one coverage pattern. This portion of the system operates in a

frequency band separated from the SCPC narrowband service. (The coverage is similar to that provided by the domestic communication satellite service.)

4.3.2.3 Frequency and Bandwidth. The U.S. Delegation to WARC79 is proposing a Land Mobile Satellite Service Allocation in the 806-860 MHz Band. This allocation would afford the option to use satellites as an extension of terrestrial networks to provide affordable mobile communications for public safety and other applications in developing countries and rural areas. For all-weather use of the satellite system, frequencies above 10 GHz have not been considered. Technical considerations drive the frequency selection to the lowest possible frequency since both the spacecraft and ground antenna gains are fixed and the space loss varies as f^{-2}. The physical size of the spacecraft antenna is the primary technical limit to this process since the diameter must increase as 1/f to maintain a constant gain. In a recent report[1], an upper antenna diameter of 200 meters was imposed by deployable reflector technology. This size antenna would allow a reasonable system design as low as the VHF band.

The system provides 10 operating channels and one control channel in each beam. The spectral occupancy depends primarily on the modulation format and multiple access technique; performance is a secondary factor. Frequency modulation and channel assignment by carrier frequency is a conventional technique. This FDMA design is simple and is based on a large body of design knowledge. Use of a network control channel offers the potential for efficient and flexible multiple access. The FDMA technique bandwidth occupancy compares favorably with advanced CDMA or TDMA systems with sophisticated voice data encoding.[2] Those techniques which use digital modulation and code or time division multiplex are not now used commercially; therefore, any ground terminal based on these approaches will be more expensive than the frequency modulation approach. Using the frequency modulation approach and assigning 25 kHz to each channel, the total spectral occupancy of the system is 1.1 MHz.

---

[1] Powell, R. V., A Future For Large Space Antennas; paper presented at the 7th AIAA Communications Satellite Systems Conference, San Diego, CA. April 23-27, 1978.

[2] Mobile multiple access study by TRW NAS5-23454, August 1977.

4.3.3 Ground Terminal

The conceptual system utilizes two basic types of ground terminals: a small, portable, inexpensive unit for the SCPC narrowband user, and a portable/fixed earth station for the wideband channel user. The design concept is based on economic considerations associated with procurement of at least 20,000 SCPC terminals and 100 earth stations.

4.3.3.1 Earth Station. The fixed earth station will be mounted in standard commercial racks to be located in the user's control center. The antenna will be sited at the user's facility. The portable version Earth station is contained within a standard S-280 shelter, or equivalent, to permit truck or aircraft transport. An antenna capable of transmitting and receiving a single wideband channel is mounted on the roof of the shelter. The terminal operates at a predetermined frequency; therefore, preset receivers and transmitters are used to provide the RF interface. Both digital and analog modulation systems are utilized to accommodate the various traffic patterns. Frequency division multiplex is provided to allow multiplexing a number of narrowband channels.

Preliminary pointing of the antenna toward the satellite uses north-south and elevation data obtained from local indicators and estimates of the required parameters for the actual shelter location. Final adjustment, to achieve optimum pointing, is manual, using a pilot signal reference transmitted from the satellite.

4.3.3.2 Narrowband Terminal. This terminal will take many forms: a hand-held unit, a man pack, or vehicular installation. The major difference in units will be operating time (prime power source, battery size) and optional features. When on, each terminal monitors the control channel when it is not communicating with another unit. The SCPC narrowbeam terminal automatically switches to the designated frequency when directed by the system controller for initiation of communications with another terminal. Each unit will operate on a subset of the frequencies contained in the covering beam. For maximum versatility, the unit will be capable of operations at any frequency in the assigned band. The antenna configuration will vary as a function of the physical unit.

4.3.4 System Performance Parameters

Typical system performance parameters are given in Appendix B. These parameters are provided to give bench marks in evaluating equipment cost-performance trade-offs.

4.4 SYSTEM COST

Assessment of a system cost objective is extremely difficult since the forcing function is sociological rather than technical. Numerous studies have been conducted to establish cost-benefit ratios and cost-effectiveness criteria for improvements in communications systems for different groups of emergencies. A value judgment on ERCS by the various governmental groups is expected to reflect both current expenditures on communications facilities and the perceived benefits.

Some examples of expanded communication services for public safety agencies have been extracted from the literature to provide an estimate of system value in economic terms.

Acadian Ambulance Service: This is a privately operated ambulance service in Mississippi. The 1978 yearly membership fee of $28 per family covered all costs which were primarily service oriented; 6% of the total operating budget was allocated to communications. The service covers 11 counties and approximately 10,000 square miles, with a population of 600,000 and a membership of 100,000 families. Use by nonmembers is on a fee basis. The system contains 31 ambulances sited at 16 substations in the region. The average response time from receipt of a call until the unit arrives at the scene is 7.6 minutes. The communication system utilizes leased space on existing structures and leased telephone lines with a 1978 operational cost of $158,000. The communications cost is therefore about $1.28 per year per family. Within the total population base the perceived value is $0.26 per person.

AAA Ambulance Service: This is a public emergency service in the greater Hattiesburg area in Mississippi. The service is supported by user fees and a tax levy. Additionally, HEW provided grants for equipment, including communications facilities and training. The initial communications

system cost (1975) is given as $260,000 with a yearly insurance and maintenance budget of $12,000. The system covers 9 counties and 4,000 square miles with a population of 170,000 people. It contains 21 ambulances and a central dispatch station with an average response time of 3.7 minutes in urban regions and 9.2 minutes in rural areas. The capitalization value was given as $1.53 per person; however, the yearly budget of $0.07 per person obviously does not cover depreciation or any leased telephone costs. With depreciation, the yearly cost of the communications capability will be in excess of $0.20 per person.

Racine, Wisconsin: The Racine County Sheriff's Department's new VHF, multiuse communications system is an example of a "latest design" system. It is currently being installed. A detailed look at future needs indicates that coverage gaps are not evident or considered to be a problem. The overall system characteristics are very similar to those desired for an ERCS. Therefore, the cost history appears directly applicable. The system contains five nodes interconnected by microwave links. Approximately 171,000 people are served by the Racine County Sheriff's Department; 154,000 considered urban and 17,000 considered rural. Within the 337 square miles of the county, the terrain varies considerably, thus enhancing the use of this system as a model. The system cost, exclusive of the mobile radios, is $540,000. The capitalization value is therefore approximately $3.16 per person. Annual costs are not currently available; however, depreciation and maintenance alone should exceed $0.40 per person.

It is impossible to strictly bound the expected value of an ERCS; however, it would appear that people will pay at least $0.25 for a suitable communications system but will not be receptive to costs which exceed $0.50 per person. Additional studies are required to narrow the bounds on this estimate as well as to establish the population base for an ERCS.

4.5 RESEARCH AND DEVELOPMENT REQUIREMENTS

The working group has identified several areas which are essential for implementation and research and development of the ERCS. The areas are:

- Systems analysis and synthesis
- Multibeam antennas

- Onboard processing
- Low cost user terminal
- Modulation/multiple access
- Components
- Propagation.

Federal Government must support the long-term R&D, since private industry has focused on near-term objectives.

4.5.1 Systems Analysis and Synthesis

Systems analysis and synthesis must be performed to provide overall guidance for the ERCS. System level studies include development and analysis of concepts to meet future needs, theoretical studies, feasibility studies, user demonstrations, traffic models and cost benefit analysis.

It is here that new technology requirements are identified and operational impacts of operations and maintenance are introduced and traded-off. Market analyses such as cost of new technology compared to present and timeliness of new services are examined.

4.5.2 Multibeam Antennas

Large space antennas provide a bright future for space communication.[3] Studies indicate that unfurlable antennas up to 200m. or 1 GHz multiple beams at 30-40m can be made available to provide up to 50 contiguous beams. Antenna problems to be investigated include:

- Weight design
- Deployment
- Stabilization (pointing and surface)
- Interconnections
- Low side lobes
- Technology (lenses/reflector/array).

4.5.3 On-Board Communications Processors

The overall concept includes a full-baseband processor in the satellite which demodulates the signal received at the satellite and then decodes,

[3] R. V. Powell, Future For Large Antennas, JPL-NASA-100.

reencodes, and remodulates the signal for transmission to ground. Information on a control channel will be used to route the message. The design concept, size, weight, and performance of this processor must be determined and simulated.

4.5.4 Low Cost User Terminal

The major emphasis to date for terminal design has been on large, fixed terminals. However, to develop a small terminal, cost must be reduced to the equivalent of terrestrial transceivers. This low cost terminal technology development must include maintenance as well as operability costs; that is, it cannot be any more sophisticated than present terrestrial walkie talkies. Microprocessors, synthesizers, and components must be developed and packaged for field use.

4.5.5 Modulation and Multiple Access

In the system design section both digital and analog modulation were considered and analog was selected based on minimizing system complexity and cost. Further investigation in this area is required to assure that the system design is based on the minimum cost approach. This task includes investigations of techniques such as voice encoding which will minimize the information bandwidth.

A major concern in any system which services a large number of independent users is the method used to share the common system elements. Numerous studies have addressed this problem either as an independent concern or in relation to existing system configurations. Within each of the major categories-- FDMA, CDMA, and TDMA --there are design trade-offs which will affect system cost and versatility. For example; in an FDMA system, the satellite power amplifier could be a single unit operating either in the saturated or linear region; or a single, saturated amplifier could be placed in each channel. A major problem in CDMA is acquisition of the code, thus introducing added complexity into the terminal design. Other systems, currently in development, utilize TDMA; however, the required bandwidth and synchronization may prove excessive for this application.

4.5.6 Components

The following components must be developed. Some of these have been implied in other R&D sections of this report but are given here again:

- High-powered linear transmitter for spacecraft
- Space qualified microprocessors, buffers, switch matrices
- Lightweight components
- High reliability.

4.5.7 Propagation

There must be continued efforts to evaluate propagation effects at proposed frequency bands to validate and verify models that exist or are being developed.

4.5.8 Other R&D Areas

- Spacecraft Pointing. This area of concern is related to antenna design. In essence, it is the problem of holding the spacecraft on station without causing excessive antenna motion. Additionally, the antenna structure is a major portion of the total spacecraft weight and can cause high inertial loads with a significant moment arm.

- Prime Power. In the system design described, there is no basic power problem if a VHF frequency is assigned for service. Increasing the frequency to UHF will increase the power requirement to 3000 watts with attendant increases in system weight. At this frequency, the major electrical load is the power amplifier, which will be directly on the power bus. An important corollary to the power system is the thermal system, which must dissipate all the input power not converted to R.F. Operation in other than a continuous load mode impacts the thermal dynamic range requirement.

5.0 PROGRAM PLAN

5.1 SYSTEM MANAGEMENT

The functions and responsibilities proposed in this section for a National Emergency Response Communications System are responsive to PD 42; Executive Order 12046; White House MOU between NSC, OSTP and Executive Agent, NCS; and Reorganization Plan #3 of 1978 (Emergency Preparedness).

The management plan for ERCS is presented in the following recommendations, giving each of the above as the source for delineating the responsibility. The contents of the Directive, Plans and Orders as each applies to the ERCS have been given in Section 1.3.

5.1.1 <u>Executive and Lead Agencies</u>

The President, with the advice of the National Security Council and the Office of Science and Technology Policy:

a) Appoints the Department of Commerce (NTIA) as Executive Agent for the development of the National Emergency Response Communications Program to include management policy and assurance of frequency allocation. (Executive Order 12046)

b) Appoints the Federal Emergency Management Agency (FEMA) as lead agency (operating and maintenance agency) for management of the National Emergency Response Communications System.

c) Appoints the Executive Agent for the National Communications System as chairman of a working group to explore near-term solutions for the Emergency Response Communications Program requirements.

5.1.1.1 Department of Commerce (NTIA) (Executive Order 12046 and PD 42)

a) Tasks National Aeronautics and Space Administration as research and development agency (PD 42)

b) Aggregates and chairs a User Steering Group which is composed of systems users from the Federal, state and local governments

c) Works with the Federal Communication Commission to assure adequate frequency allocation.

5.1.1.2 Federal Emergency Management Agency (FEMA): (Reorganization Plan #3)

a) Establishes a mechanism for assuming operational management of the program with the advice of the User Steering Group

b) Coordinates with NASA for applicable technology of the space segment and ground control stations including launch, test and evaluation of interface with existing systems

c) Establishes through Government Services Administration (GSA) a contractual mechanism with industry for the development of systems interface equipment and provides that mechanism to the users for central procurement

d) Establishes and manages an Operating Fund composed of system users, which will pay for operation and maintenance of the system after test and evaluation

e) In coordination with the User Steering Group and the NCS, formulates systems protocols, system priorities, operations and maintenance of system control centers.

5.1.1.3 The Executive Agent for the National Communications System (White House MOU)

a) Works with FEMA and User Steering Group to establish national protocols, priorities, etc.

b) Establishes a working group to explore near-term solutions for the National Emergency Response Communications System requirement and presents those solutions to the appropriate department or agency for implementation.

5.1.2 The User Community

a) Develops their particular systems usage parameters, priorities, etc.

b) Pays a proportionate share of the Operating Fund based on their capacity and usage

c) Purchases the needed ground terminals and interface devices through the GSA-established procurement mechanism.

5.2 SYSTEMS OPERATION

5.2.1 Funding Profile

The financing of the Emergency Response Communications Systems falls into various categories which relate to research and development, hardware procurement, operation and maintenance, program administration, and contingencies. Although the objective is to obtain this service from the private sector, Government funding must be applied to develop technology and to start the program. Responsibility for the funding is shown in Figure 5.1 and is visualized as follows:

a) The Federal Government will provide the money incident to fulfilling the research and development stages, first launch, and the test evaluations. When the system meets the specified performance criteria, the system will be transferred to the operating agency.

b) The users, through an operating fund managed by FEAM and the User Steering Group, will be fiscally responsible for the

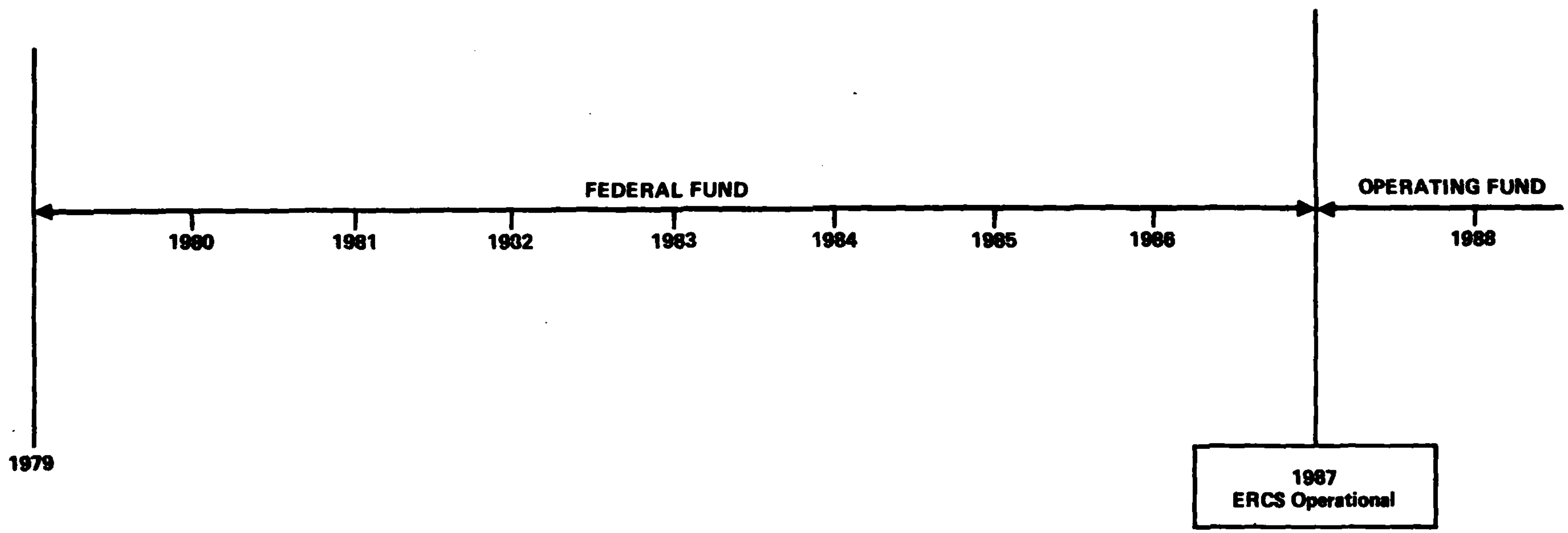


FIGURE 5.1. FUNDING RESPONSIBILITY TIMELINE

operation of the Emergency Response Communication System. These funds will be held and serviced by an established financial institution or an appropriately chartered foundation. The money will be given to private industry for the services rendered to the users.

c) The users themselves will be responsible for the purchase of their ground equipment through the procurement mechanism established by FEMA and GSA.

For protecting the Federal investment described above and ensuring long-term monitoring of the public interests, the lead agency (FEMA) will provide for program monitoring. The Government will guarantee this item at an amount and for a period to be determined and fix it by contract negotiation.

The users of the system will be required to develop their operational plans to include the interfaces with tariffed services and existing communications systems.

5.2.2 Schedule

A timeline for the program is shown in Figure 5.2.

5.2.3 Program Considerations

When the sources of research and development monies have been officially committed, the Government will prepare and issue a request for proposals (RFP). While other contractor selection criteria equally important will be specified, the deciding factor for choosing the contractor will be rates offered for service. To facilitate the rate-making process, rates can rest upon some convenient basis such as numbers of channels, transponder space, or "pencil" beams. Whatever the criterion, it should provide for the very small user as well as the large user.

To ensure continuing responsiveness of the contractor to national emergency response objectives, the lead agency should appoint a strong program manager. The person selected should be contractually designated as the official point of contact between the Government and the contractor.

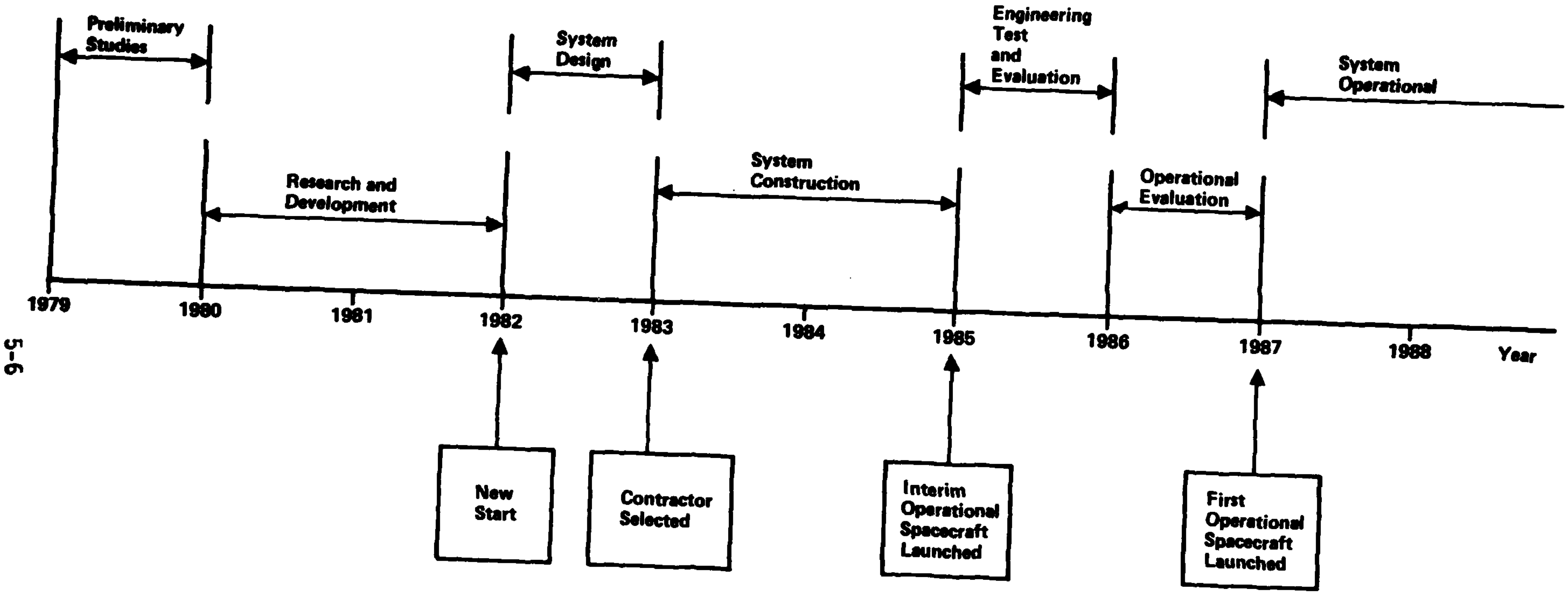


FIGURE 5.2. PROGRAM PLAN TIMELINE

The program manager will control a task force that is commensurate in size with implementing this program. The lead agency will provide the program manager with the financial, housekeeping, and manning resources consistent with efficient management.

The complex nature of the system suggests that a single contractor be selected to design all components of the system, satellite and ground terminals and to participate in the test and evaluation effort. Ideally, this contractor will have been heavily involved in the R&D effort to assure a smooth transition from the prototype designs to the final design.

Responsiveness of the final design to the needs of the multiple sponsoring agencies will require establishment of joint liaison groups with the lead agency. These joint liaison groups will include ICSAR, NTIA, and FEMA, in addition to user steering groups from the states and other Federal agencies.

5.3 RESEARCH AND DEVELOPMENT

The research and development effort must be carefully coordinated to assure the Government that the effort is properly targeted toward meeting the system needs. To this end, both the system engineering effort and the detailed hardware activities must be placed under one manager and, preferably, under one contractor. Specific program activities have been discussed in Section 4.3, and a potential management structure in Section 5.1.

5.4 OPERATION AND MAINTENANCE

During the pre-operational and operational phases the users will be involved in sharing the ERCS through FEMA. In these later phases, NASA involvement will be primarily as observer and consultant. Operation, maintenenace, administration and satellite replenishment are the responsibility of the contractor. The source of revenues available to the contractor are to be derived from the users. An individual state or Federal agency which at first does not become a user and later decides to use the satellite can contribute to the Operating Fund at that time. As a simple matter of economic equality, service would probably not be available to those organizations failing to contribute to the fund. Each subscriber will pay an annual rental charge which competitive bidding will set as described hereinafter.

The Operating Fund or foundation, as chosen, will represent the equity and vested rights in the system of all Federal, state, and local contributors. The lead agency will develop procedures for using the fund as the medium for receiving and disbursing monies. Features envisioned include annual payment to the fund of revenues owed by each user and monthly disbursement to the contractor. The prospect of the fund growing by virtue of profitable investment to the point where the contractor could launch new satellites when required is realistic. Indeed, if the national economy is strong and growth of the fund is good, the rates paid by users probably could be reduced.

The space element of the Emergency Response Communications System entails high volume, sustained funding whereas the costs of the ground element can be low and fluctuate according to local needs and budgets. Total responsibility for acquiring and fielding Earth stations will rest with the user. In concert with the vested users through the user steering group, the lead agency will promulgate the rules whereby users may be authorized and operations conducted. The major premise of the ad hoc working group resides in the concept that any authorized user can access the satellite for the entire gamut of search and rescue missions, disaster relief, and other officially approved operations. All services will be specified in the contract.

APPENDIX A

SUMMARY REPORTS OF REGIONAL MEETING

This appendix contains summary reports of the participants of the four regional meetings held by the ICSAR Working Group on Emergency Response Communications Program.

These meetings were:

- Western Region, Los Angeles, California May 17-18, 1978
- Midwest Region, Des Moines, Iowa August 2-3, 1978
- Southeast Region, Raleigh, North Carolina October 26-27, 1978
- Northeast Region, Hershey, Pennsylvania November 20-21, 1978

ICSAR WORKING GROUP ON EMERGENCY RESPONSE
COMMUNICATIONS PROGRAM

SUMMARY OF MEETING HELD AT BONAVENTURE
HOTEL, LOS ANGELES, CALIFORNIA

MAY 17 AND 18, 1978

The proceedings of the meeting as presented here are not in strict chronological order, but are grouped under presentations by state, Federal, and non-governmental personnel. Major Hufnagel gave a presentation on the background and history of the working group, its goals, and purposes. Federal agencies recognize their own needs for coordination and believe that this same need exists at the state and local level. The purpose of our meeting here is to learn from the attendees what these needs are. With this input, the working group can then consider a systems approach to meet the problems.

Mr. Luzius gave a presentation on the history, structure, and purposes of the Interagency Committee on Search and Rescue, ICSAR. ICSAR is a committee of the five agencies that are signatories to the National SAR Plan. These signatories are the Departments of Transportation, Defense, and Commerce, and the FCC and NASA. Observers to ICSAR proceedings are the Departments of State, Interior, HUD, and HEW. Interior has been invited to become a signatory to the National SAR Plan, and thus a full member of ICSAR. Other organizations may become "ad hoc" observers to ICSAR. The National Association for Search and Rescue (NASAR), and the Aircraft Owners and Pilots Association (AOPA), are ad hoc observers, and there is room for other organizations to send such observers if they wish. ICSAR is the parent organization which authorized the formation of this working group.

CALIFORNIA

Mr. Mason Riegel, State Communications Division, State of California.

Mr. Riegel discussed California's work with Hughes Aircraft and NASA for research and development on SYNCOM IV, emergency communications for potential disaster situations, and a forthcoming satellite experimental program.

Mr. Charles Columbro, Chief Telecommunications Officer, Department of Forestry, State of California.

Mr. Columbro discussed California's unique problems in the protection of 35,000,000 acres of land. Communications equipment consists of 29 forestry conservation lines, 1800 mobile radios, 1200 portable radios, 30 dispatch centers, and 160 mobile relays. In fighting forest fires, the California Forest Service must occasionally set up a "tent city" of 1000 overnight. Good communications are desperately needed. One of the biggest frustrations encountered is

the inability for assisting aircraft to communicate directly with ground parties. Mr. Columbro believes that a satellite communications system would be a solution to many of his problems.

Captain Brian M. Groves, State Military Department, California National Guard.

Captain Groves discussed the provision of communications channels and National Guard helicopters to the California Department of Forestry for assistance in fighting forest fires. Captain Groves made the point that military aircraft are unable to talk to the man on the ground, fighting the fire. A communications system is needed.

Mr. Archie Noriega, Communications Coordinator, Department of Water Resources, State of California.

Experimental work is being carried on by California in conjunction with NASA on the use of satellites in providing a complete snow measuring system.

Mr. Carl Ingersoll, Communications Section, California Highway Patrol.

Mr. Ingersoll discussed in some detail the California Highway Patrol's communication system, its problems, and needs. The CHP can communicate with other law enforcement agencies, military (MAST) helicopters (Ft. Ord helicopters with CHP radios), and state helicopters. The present system depends largely on microwave facilities which could be partially wiped out in forest fires or earthquakes. To meet this potential threat, the CHP is experimenting with satellite communications such as ATS-3.

Mr. Don Irwin, Senior Coordinator of Communications, Office of Emergency Services, State of California.

We have tackled the problem five years downstream, but what are we going to do tomorrow? A command post in the sky would be very costly. We would know that there was a disaster, but we wouldn't have the equipment to go out and look for victims. Our role in the Office of Emergency Services is to coordinate, and monitor the activity within the state.

Number 1. <u>Emergency Broadcast System (EBS) for the state</u>. How do we tell the people what to do in an emergency? Where are they to go? In 1963, the DCPA announced a change from CONELRAD to EBS. EBS has 25 operational areas in California. We need to identify communications program control stations in each area. We're going to identify alternative stations. All participating media will become involved and carry the broadcasts when the signal has been given that EBS has been activated. The city would notify the state and the communications program would sound the 2-tone signal. All other stations in

the area would then carry the program so that they could tell the people what action to take to save lives and property. Also we must provide protection capability to the radio stations. Much work remains to be done.

Number 2. National Warning System, NWS. We have within the nation a national warning system controlled from NWS, Colorado Springs, Colorado, with secondary units on the East Coast and one down in the South. They can activate all systems to give early warning in cases of any disaster. They are used for a multitude of things. SAR, Scott Air Force Base, can go through Colorado Springs. The state has a warning system in Sacramento. There are Federal points down through local points within the state. The State of California is critical of this program. We have a number of warning points for 58 counties within the state, but a large number of areas have no access to a warning system. There are 1,600,000 people with no access.

Number 3. The need for a compatible frequency for SAR, 155 to 160 MHz. We need a frequency compatible with those available right now. In Northern California and Southern California, NASAR went to the FCC for an exclusive frequency. There is a tremendous need for it. In an 8.3 earthquake in Los Angeles, there would be 40,000 dead and miles of rubble. You really need a frequency to coordinate your needs at a time like that. You need to talk to command centers, medical facilities, hospitals, mutual aid centers throughout the state.

ALASKA

Mr. Robert Walp, Director of Communications, State of Alaska.

Mr. Walp reviewed the history of communications in Alaska from its military beginnings to the present system operated by RCA. Alaska has successfully used the ATS-1 for emergency medical communications.

IOWA

Mr. James Smidt, Division of Communications, State of Iowa.

Iowa has an emergency communications problem in the rural areas, primarily for emergency medical services. A patient is sometimes 4 or 5 miles from the nearest telephone. Iowa needs a system (satellite, landline, or microwave) for the medic on the scene to receive instructions from a cardiologist, so that treatment of the patient can begin before the ambulance gets to the hospital. A satellite experiment on emergency communications was carried out with the assistance of NASA, and the Governor of Iowa was impressed with the demonstration. Mr. Smidt believes a satellite communications system, shared by many users, may be the answer to Iowa's problems. Mr. Smidt offered to host a future conference of this working group in Des Moines, Iowa, to which other midwestern states would be invited.

ARIZONA

Mr. Harry E. Border, Technical Operations Officer, Arizona Division of Emergency Services.

Mr. Border stated that the Arizona Highway Patrol has an excellent statewide microwave communications system, but it is used for traffic only. Other than this system for traffic, Arizona communications capability is weak. There is no state communications division. Search and Rescue is the responsibility of the individual county sheriff. Of the 14 counties in Arizona, only 4 have a reasonably good communications organization. There is no county-to-county communications system or air-to-ground communications. Some CB and amateur radio monitors are available to assist in emergencies.

Mr. C. L. "Skip" Barnes, SAR Coordinator and Disaster Liaison Officer, Maricaopa Sheriff's Department, Arizona.

Mr. Barnes reinforced the comments of Mr. Border on the situation in Arizona. He pointed out that he had an aircraft radio in his car. He believes that a satellite communications system would answer many of his problems.

FEDERAL

Several Federal agency members of the working group presented briefings on their current emergency communications systems and related matters.

FEDERAL COMMUNICATIONS COMMISSION

Mr. Jeffrey B. Young, Field Operations Bureau/Enforcement, Federal Communications Commission.

The FCC is involved in emergency communications through frequency allocation functions, licensing and rulemaking, direction finding for SAR, and direction finding for law enforcement. The FCC operates monitoring DF stations which can triangulate an emergency broadcast, thus giving a position of a distressed ship or aircraft. In local short range DF operations, the FCC can eliminate interference on emergency frequencies or locate non-distress ELT transmissions. Funds and resources are limited, so that there are not enough people or equipment to go around.

NATIONAL WEATHER SERVICE

Mr. Herbert S. Groper, Acting Chief, Disaster Preparedness Staff, National Weather Service.

NWS discovered that the mere broadcast of a warning by NWS to the public was insufficient to insure proper public response. The public will respond if some local official (mayor on TV--police squad car in neighborhood) will repeat the warning and advise evacuation or another proper course of action.

Present communications for emergency weather conditions are inadequate. There is an insufficient number of National Weather Stations (NAWS). Telephone communications are frequently cut off by the severe weather or flood being reported. Hams and CB operators are a vital link but they must be trained and coordinated. Local officials must have good organizational planning and effective communications.

DEFENSE CIVIL PREPAREDNESS AGENCY (DCPA)

Mr. Ralph D. Sinnot, Director, Communications Network Engineering, DCPA.

The DCPA National Warning System (NAWAS) is a four wire party line telephone system connecting four regional DCPA Centers with 1200 points nationwide manned around the clock. DCPA also operates a Civil Defense National Teletype System (CDNATS) backed up by a Civil Defense National Radio System (CDNARS). DCPA has the capability to send emergency communications teams with equipment to the site of a disaster. DCPA is encouraging the use of CB for emergency communications.

U. S. AIR FORCE

LCOL George Stutts, Air Force Rescue Coordination Center, Scott AFB, Illinois.

RCC, Scott AFB, is responsible for coordinating inland SAR under the National SAR plan. On an annual basis we conduct approximately 1,500 lost children missions, 300 "lost person" missions, 300 missing aircraft searches, and we run down about 6,000 ELT transmission reports. Additionally we assist the Coast Guard in marine SAR. We have good land line communications, namely FTS, Autovon, direct link to St. Louis Air Traffic Service, and commercial telephone. We average 300 to 400 calls daily on weekdays and up to 1,000 calls per day on weekends and holidays. Our primary communications problem is talking to the man on the ground in the field. For example, an aircraft over a search area spots something on the ground, calls Scott RCC who then contacts a ham operator; the ham operator calls a local operator who then must walk out and give the message to a man on the ground. Perhaps a satellite communications system will correct this.

Captain Eldon Georg, Air Force Communications Service, Scott AFB, Illinois.

It is important for the RCC to communicate with the on-scene commander. We need a voice circuit connecting the RCC, on-scene aircraft, and ground parties. Frequency protocol will be required to isolate our communications from others in the area.

Master Sergeant William Kratch, 303rd Air Rescue and Recovery Squadron, March AFB, California.

Sergeant Kratch is a communications expert engaged in Air Force Search and Rescue operations. He related a story of an SAR incident during which a

person died unnecessarily because rescue units could not talk to each other. He then outlined the steps that he and some co-workers had taken to cure the problem, and spoke of his frustration about the lack of funds to implement corrective action. Major Hufnagel stated that procurement of the necessary equipment for a significant number of Air Force SAR aircraft had been approved.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. John Woodruff, COMRTS Manager, Goddard Space Flight Center, NASA.

Mr. Woodruff gave a brief report on space communications experiments using the ATS-6. He mentioned that the ground portable receiver used in the experiments cost about $9000, but that costs could be reduced to about $2000 to $3000 by mass production.

U.S. COAST GUARD

LCDR James L. Barth, Telecommunications Management Division, U.S. Coast Guard Headquarters.

The Coast Guard Communications system exists to satisfy the needs of the maritime community. Long range distress communications coverage is maintained by Coast Guard Communications Stations located in nine Coast Guard Districts around the United States. Additionally we maintain a VHF-FM distress system for boaters and ships operating between the coast and 20 miles offshore. We maintain four mobile communications trailers that can be transferred by helicopter or towed by a large vehicle. These are available on six hour notice for use in widespread emergencies, or remote SAR cases. With our C-130s, helicopters, and communications trailers we can maintain communications with state, local, and volunteer groups. We are involved in the NASA SAR satellite project.

U.S. FOREST SERVICE

Mr. Reid A. Marks, Special Agent, U. S. Forest Service.

The U. S. Forest Service is involved with the local sheriffs in SAR in National Forests. Compatible communications is a very difficult problem. The service has an aircraft which has several transmitting frequencies ("can talk to the whole world"), but can receive on only one. The aircraft cannot talk to rescue men on the ground because they are not on the same frequency. We need communications from command center to command center. We should be able to flip a switch or hit a button to let others know we have a problem.

NON-GOVERNMENTAL ORGANIZATIONS

Technology Service Corporation.

Mr. Klaus Schroeder, Senior Scientist.

This corporation is hopeful of achieving a direct broadcast satellite system which may be locally controlled and public service oriented. The system is designed for putting TV into homes via satellite, but emergency communications would be a desirable side benefit. In addition to TV and emergency broadcasting, the system may provide teleconferencing and telemail.

AFFILIATED VOLUNTEER EMERGENCY RADIO TEAMS (AVERT)

Mr. Robert N. Dyruff, Administrative Coordinator, AVERT, and Assistant Director, American Radio League.

AVERT teams provide local, medium, and long-range communications over complex circuits. AVERT is particularly valuable in a local community immediately following an emergency or disaster. AVERT can handle emergency communications for up to 72 hours after the emergency occurs, during which period all services can be flown in by helicopter. AVERT was tested last July (1977) when the Santa Barbara fire hit. The commercial telephone system was largely knocked out. Since the Red Cross is locally based, their lines were out also. AVERT filled the gap. AVERT has proved its worth in many E.M.S. cases also.

WRAP UP

Mr. Don Irwin, Office of Emergency Services, California.

To summarize, the need for this working group is to come up with solutions to our emergency and Search and Rescue communications problems:

1. We must address the need to provide the public with an explanation of the warning system. This is a DCPA problem.

2. Emergency Broadcast System (ENS). This is a serious item; we need to come up with a solution. This is an FCC problem.

3. Search and Rescue. How do you at Scott AFB and other levels that use Search and Rescue efforts on the ground feel about our program? How serious are you about this? Is it something that you definitely need? You have supported the Civil Air Patrol. You have established frequencies that they can use. Why can't you do the same thing for local Search and Rescue? We have talked about the problem. They have a need to communicate. It was pointed out by the Colonel from Scott AFB that we would like to have communications with those people on the scene.

We need receiver capability because our hand-held receivers won't work. We must try to find frequency compatibility with 155. You did it for the CAP. If they have the capability of communicating through low power receiver packages and little hand-held receivers, look into that system for local SAR units.

We should be able to communicate with each other locally without interfacing with a satellite. You could activate a tone from Scott and

could monitor without interfering with the operation. It's something that could be looked into.

CLOSING REMARKS

Major Hufnagel

Please go back home and think about what we have discussed here. See what your requirements are. What would they be if you had a blank check and could buy anything? After buying anything you need, those requirements that are left unsatisfied are the parameters to be addressed by the Emergency Response Communications Program. If you have anything you wish to discuss, I'll be available to come out and talk as long as my time and funds hold out. It's your program. We are just trying to put it all toggther. It's all a matter of articulating what we need and telling the technicians what we want.

We need you to send in your estimates of requirements as rapidly as possible. We need spokesmen from every state government and we need those spokesmen to be speaking for their local guys.

ICSAR WORKING GROUP ON EMERGENCY RESPONSE
COMMUNICATIONS PROGRAM

MIDWEST CONFERENCE HOSTED BY
THE STATE OF IOWA, HYATT HOTEL, DES MOINES
AUGUST 2 AND 3, 1978

Summary of Meeting

The meeting was opened by Mr. Glen D. Anderson, Jr., Iowa Division of Communications, representing Governor Ray. Mr. Stanley McCausland, Iowa Department of General Services, gave the welcoming address. He stated that Iowa is very interested in improving their emergency communications capability, with emphasis on coordination between agencies and wishes to determine what capabilities are lacking. Iowa also wants to learn how other states are meeting their responsibilities.

Major Hufnagel gave a presentation on the background and history of the working group together with its goals and purposes. He stressed the importance of receiving Iowa's inputs regarding her needs. Mr. Luzius gave a background briefing on the Interagency Committee on Search and Rescue (ICSAR) and its relationship to this working group. LCOL George Eldridge, USAF, Assistant Director of the Air Force Rescue Coordination Center, Scott AFB, gave a briefing on the duties and operation of the Inland SAR coordinator and the Air Force RCC, Scott AFB, Illinois. Members of the "core" working group then presented a briefing on the working group's accomplishments to date, including the "strawman" concept of operations as envisioned by the group.

Ms. Lois Clark McCoy, Administrator of NASAR, the National Association for Search and Rescue, then gave a presentation. She emphasized the fact that lack of efficiency in emergency communications can cause loss of human life. NASAR has requested a grant from the National Aeronautics and Space Administration, NASA, for space and time on the ATS-6 communications satellite for use in an emergency communications test program. The test will involve a simulation of actual emergency response operations for a 12-month period. Ten "briefcase" transceivers will be put together and used in the test operations. Ms. McCoy stated that a big problem in justifying more resources for inland SAR is the lack of an adequate data base. NASAR is trying to develop such a data base with the help of several Federal, state, and volunteer agencies.

At this point the various states in attendance made presentations outlining their existing emergency communications systems and requirements.

In general, the status of emergency communications in Iowa is very good. The state police system, particularly, is excellent. Emergency Medical Service communications need improvement. A system is in being, but in some areas, there are ambulances without radios. The existing system is UHF. EMS

needs a "UHF advance life support system," and a "unified approach to emergencies." They had a satellite EMS communications demonstration in conjunction with NASA in May 1978, and many people in the state are very interested in satellite communications as a result. The transmission of vital signs via satellite was a success during this demonstration. Iowa officials involved in emergency warning systems and disaster control communications are not satisfied with existing communications. The warning system is weak. They would like to meet a "two-minute dissemination" criterion and an indoor warning system. Their present system cannot do this. Point-to-point communications are landline, and hence likely to be knocked out by tornadoes, floods, etc., just when they are most needed. A satellite communications system shows promise of solving this problem. Another communications need in the state is for a better emergency communications organization, and more definitive command and control responsibility assignments. Major Beaman made a strong recommendation that the ICSAR working group seek the endorsement of the National Sheriffs' Association and the National Association of the Chiefs of Police for its efforts. Such endorsement by these groups at the national level would give our Emergency Response Communications Program excellent credibility throughout all the states.

ILLINOIS

Illinois has an extensive and well organized state communications system. Illinois has been a leader in emergency communications and established the first statewide emergency communications network in 1960. In 1973, Illinois promoted a nationwide emergency communications network. The Illinois system links state aircraft and vehicles with the Departments of Transportation, Law Enforcement, and Conservation. For "Emergency Services and Disaster" communications, the state has nine regional coordination facilities, seven of which are now manned 24 hours a day. Mr. Stine and Mr. Novy remain open-minded about a satellite communications system, but they feel there are questions to be resolved before they can endorse such a system. There are existing needs in the state which must be met before funds can be allocated to a satellite system.

KANSAS

Kansas has an extensive state communications system in existence now representing a huge investment. Mr. Turrentine feels there would be considerable taxpayer resistance to any additional state expenditures for more communications capability. A statewide microwave system was proposed a few years ago but was not accepted. The only area where expansion might be acceptable is in EMS communications. Mr. Turrentine states that in addition to communications equipment, good organization is required. In the recent "whipoorwill" disaster in Kansas, there was confusion among people, apparently due to inadequate organization. A satellite system might possibly answer some communications problems in the future.

MISSOURI

Missouri has a well developed state communications system. However, there are areas where improvement is needed. The EMS trauma crews need better communications. Some of the hospitals do not have 24-hour physician coverage. It is feared that some of their links fanning out from the communications control center would go down during disasters. A need for gradual increase in facilities is anticipated and a satellite would avoid the outages caused by tornadoes, and floods. The speakers were concerned about the effect that a high altitude nuclear burst would have on a satellite system, and the present lack of land-mobile frequencies authorized for communications with satellites.

SOUTH DAKOTA

South Dakota's existing emergency communications system has many shortcomings. Money, personnel, and adequate training are all in short supply.

KENTUCKY

Kentucky has an effective communications system. The state spent $22.8M to develop the Kentucky Emergency Warning System. However, there are still problems. In April 1974, 73 lives were lost due to inadequate communications. Landlines went out immediately. Persistent problems are: no communications in the immediate area of a disaster (flood or tornado destroys facilities); no communications interface with aircraft; no means of transmitting warnings over full 24-hour day; and no standard means of communicating locally during emergency operations. A satellite communications system would significantly improve our posture by providing all weather point-to-point statewide communications capability. Dead spots would be eliminated and floods or tornadoes would not knock it out. Mr. Arnett stated that this meeting is the first he has ever known to address these problems either intra-state or nationwide. The effort of the working group is most welcome because most states do not have the technical ability or funds to develop such a communications program. Mr. Arnett heartily endorses a satellite emergency communications system.

FLORIDA

Mr. Houston stated that Florida's problems were very similar to those listed by the other states. Florida would like to participate in a satellite communications program if it proved to be cost effective. Mr. Houston believes that the system will be cost effective and states that Florida needs it.

ICSAR WORKING GROUP ON EMERGENCY RESPONSE
COMMUNICATIONS PROGRAM

SOUTHEAST CONFERENCE ON EMERGENCY RESPONSE COMMUNICATIONS
OCTOBER 26 AND 27, 1978
HOLIDAY INN, RALEIGH, NORTH CAROLINA

Summary of Meeting

The conference was opened by Chairman Hyde. The conference was organized as a joint meeting of the North Carolina Task Force on Telecommunications and the ICSAR Working Group on Emergency Response Communications Program. The Honorable Joseph W. Grimsley, Secretary, North Carolina Department of Administration representing Governor James B. Hunt, Jr., gave the opening address. He stated that North Carolina should benefit from this gathering. Emergency communications, especially for Emergency Medical Services, are now becoming more and more important, particularly in the mountainous western counties.

Major Hufnagel gave a briefing on the background, goals, and purposes of the working group. He outlined the progress of our efforts to date.

The Honorable Henry Geller, Administrator, National Telecommunications and Information Administration, addressed the group. Mr. Geller explained that NTIA is the successor to the Office of Telecommunications Policy, and now comes under the Secretary of Commerce. NTIA has four areas of concern, namely, spectrum, research, long-range policy, and telecommunications applications. Basically NTIA's mission is to use telecommunications more efficiently. One NTIA effort is to explore extension of TV coverage to all rural areas of the United States. NTIA supports the Land Mobile Satellite System frequency reservations in WARC. It also supports the concept of a Public Service Satellite. Mr. Geller sees an emergency satellite communications system as a possible answer to such problems as the one that occurred about five years ago in Indiana, where a tornado wiped out a town and the outside world did not learn of the disaster for ten hours. After this, it took an additional five hours to restore adequate communications to effect relief measures. Interest in emergency communications is growing but there is a danger of the momentum being lost. ATS-6 will be turned off in September, 1979. NTIA must be made aware of the needs of all potential users of an emergency satellite communications system. This particularly includes users in addition to Federal government users. A presidential decision for Federal support of the public service satellite concept is a prime concern of NTIA. Mr. Geller stated that NTIA will encourage joint development of the Public Service Satellite concept by NASA, private industry, and ultimate users. NTIA believes that the U.S. position for WARC-79 will support accommodation of a Land Mobile Satellite Service. NTIA supports 806-890 MHz and believes that the FCC has been persuaded to go along.

Mr. Luzius gave a background briefing on the Interagency Committee on Search and Rescue (ICSAR) and its relationship to this working group. Mr. Frank Adams explained our concept of operations. Mr. Rex MacKinnon presented the technical concept.

NORTH CAROLINA

Mr. Kelly pointed out that North Carolina's communications problems varied with the area. In coastal regions, users encounter interference with others on the same frequencies. In mountainous regions, the problems are mainly in establishing communications at all. Radio and television do not get through to many people living in the mountains. Mr. Blalock stated that most of the emphasis in the past was to look out for the provider of telecommunications, more than for the user. Mr. Blalock stated that in North Carolina the fire departments, ambulance service, rescue service, police, etc. all have sophisticated radio and landline communications systems but they need to improve the interface between the various systems. A consolidated Public Safety Communications Center is needed. All too often, cities and counties do not cooperate. How do we lick this problem? "Gadgets" alone won't do it. We need a good communications system. Frequency allocations must be coordinated. Communications management responsibilities must be established at the various levels of state and local government. The State of North Carolina should revamp its communications management structure. There should be more emphasis on good management and less emphasis on hardware.

Mr. Smith of APCO, North Carolina, stated that the primary problem in his area is the lack of local communications management. "How can we communicate with our local neighbors?" These basic problems must be resolved before we can think seriously about satellite communications.

GEORGIA

Mr. Hammonds of Georgia stated that communications problems are more operational than technical. Georgia wants to determine "How can we best spend available money to save the most lives?"

FLORIDA

Mr. Byrd of Florida stated that their telecommunications staff is heavily "technician oriented." He stated that the satellite concept must be proven cost-effective before the State of Florida can support it. Florida has been successful in working out coordination problems with adjacent states.

ICSAR WORKING GROUP ON EMERGENCY RESPONSE
COMMUNICATIONS PROGRAM

TELECOMMUNICATIONS CONFERENCE HOSTED BY
THE STATE OF PENNSYLVANIA AT THE HERSHEY
CONVENTION CENTER, HERSHEY, PENNSYLVANIA
NOVEMBER 20 AND 21, 1978

Summary of Meeting

DCPA is primarily oriented towards civil defense in the event of nuclear warfare. It cooperates with The Federal Disaster Assistance Administration (FDAA) in peacetime emergencies. Under a recent presidential reorganization order, a new agency, the Federal Emergency Management Administration (FEMA) will be formed from DCPA and other Federal agencies. FEMA will incorporate DCPA, FDAA, and the Federal Preparedness Agency (FPA). It will also assume responsibility for the Earthquake Hazards Reduction Program, Dam Safety Coordination and Planning, The National Warning System, Flood Control, some duties of the National Weather Service, and maintenance of liaison with Search and Rescue agencies. Such an extensive amalgamation of existing agencies and programs will require a careful phase-in to minimize organizational difficulties. A unified FEMA budget is anticipated by 1980.

Mr. Holcomb discussed an RFP recently issued by DCPA for an emergency satellite communications system. The objective of the program is to provide a capability of restoring communications in a disaster area within one hour and to provide a nationwide disaster communications network with voice and data capability. The system will include fixed earth stations, transportable earth stations, and portable earth stations.

Ms. Lois Clark McCoy of the National Association for Search and Rescue (NASAR) discussed the need for improvement in emergency communications. She stated that accidental deaths impacted the GNP by a loss of $56 billion per year. The causes of these deaths included recreation, sporting, boating, general aviation, chemical accidents, "disasters," and "cataclysms." A "cataclysm" is a single incident, e.g., flood or earthquake, resulting in more than 25 deaths. She said that contrary to popular opinion, the East is just as prone to cataclysms as the West. In fact, last year there were 8 cataclysms east of the Mississippi River, and none west of it.

PENNSYLVANIA

A discussion and working session was held on the subject of how states are dealing with the issues involved in Emergency Medical Services (EMS) telecommunications. Mr. John Harkins of Pennsylvania gave a briefing on EMS communications in his state. Pennsylvania has a good comprehensive state EMS communications plan. A "common system" approach is used, with emphasis on flexibility

and availability. The system must serve nine Health Districts, 250 hospitals, and 1,800 ambulances. The system relies on landlines, radios in "emergency centers," and radios in ambulances. The landline system is dependent upon 48 different telephone companies in the state. Pennsylvania has a dispatcher training program. They are presently using one police helicopter, with plans for obtaining and equipping six "hueys" for EMS work. The goal of the common system is to make EMS communications available to 90% of the state.

FEDERAL COMMUNICATIONS COMMISSION

Mr. Herb Newman of the Federal Communications Commission (FCC), Washington, D.C., then gave a presentation of FCC's role in emergency communications. The FCC doesn't provide any communications itself. Its role consists of licensing, regulating, and monitoring. It maintains liaison with the National Industrial Advisory Committee (NIAC) and the State Emergency Communications Committee. Both of these groups are involved in planning for emergency communications. He described the Emergency Broadcast System used by state and local governments in times of emergency. The governor, mayors, and other officials have access to the system when required. Mr. Newman also stated that amateur and CB nets were available and useful for emergency communications and should not be overlooked.

NATIONAL TELECOMMUNICATIONS AND INFORMATION AGENCY

Mr. Roger Reinke of the National Telecommunications and Information Agency then gave a presentation on the NTIA. He stated that the NTIA was an outgrowth of the old OTP. It was created on March 27, 1978. NTIA oversees the government's use of spectrum, and gets involved in policy issues, research, and telecommunications applications. The educational broadcast program, formerly under HEW, is now under NTIA. The "Information" part of NTIA is concerned primarily with the privacy act implications of "Information," and is not concerned with data processing information. NTIA, under a recent executive order, has been asked to coordinate communications among Federal, state, and local entities involved in EMS. HEW and DOT are deeply involved in EMS, and NTIA is working with them on communications matters.

GENERAL

At this time a discussion was held among state communications representatives regarding their problems in EMS, Civil Defense, disaster response, and law enforcement. States varied in their approach to management of their telecommunications systems. In most states, communications are managed by a distinct telecommunications branch in the state government, while in others telecommunications are managed either entirely by the state police or entirely by the state civil defense organization. Most of the states reported problems in VHF-FM and CB saturation. One solution to the VHF saturation problem is "trunking." The Law Enforcement Assistance Administration (LEAA) has a program underway to set up trunked radio systems in several model cities. Pennsylvania is planning for a statewide trunked system in the next 5 years, if they get the necessary budget support.

The Honorable Milton J. Shapp, Governor of Pennsylvania, addressed the group. Governor Shapp expressed great interest in the program and made inquiries about the problem of amalgamating the needs of a variety of users, and about the inability of military aircraft to talk to sheriffs' vehicles, etc. He was assured that the DoD, specifically the Air Force, had undertaken a program to modify Air Force HC-130 aircraft to include VHF-FM. The modification will be accomplished by September 1979. Governor Shapp (who is a "ham" radio operator) then advised the group not to overlook amateur radio operators and CB nets in emergency communications. He stated that in some recent flood emergencies, they gave useful information on increasing water levels.

APPENDIX B
SYSTEM PERFORMANCE PARAMETERS

Typical performance parameters are given in Tables B.1 to B.4. These tables give the broad system parameters for a VHF and UHF satellite system so that a non-technical reader can obtain some idea of the size and weight of the spacecraft.

TABLE B.1

ESTIMATED SATELLITE WEIGHT BUDGET

	LBS	
	VHF	UHF
Antenna	27,000	830
Payload	3,000	3,000
Position and Orientation	15,500	2,700
Structure	7,800	1,340
Command & Control Electronics	300	300
Power	120	800
Estimated Spacecraft Weight	53,720	8,970

TABLE B.2

ESTIMATED SATELLITE PRIME POWER

	VHF	UHF
Downlink EIRP (per channel)	59.2 dBm	83.7 dBm
Antenna Gain	47.0 dB	47.0 dB
Feed Loss (Budget)	4.0 dB	4.0 dB
RF Power per Channel	16.2 dBm	30.7 dBm
Conversion Efficiency	6.0 dB	6.0 dB
D.C. Power per Channel	22.2 dBm	36.7 dBm
555 Channel Peak Load	27.5 dB	27.5 dB
Peak D.C. Power (Transmit)	93.3 watts	2630.0 watts
Housekeeping Power	200.0 watts	200.0 watts
Receiver Power	100.0 watts	100.0 watts
Controller/Switch Power	50.0 watts	50.0 watts
Estimated Prime Power	443.3 watts	2980.0 watts

TABLE B.3

TYPICAL UPLINK DESIGN

<u>Noise Budget</u>	
Satellite	
Satellite Receiver noise power density ($T_s = 600^oK$)	-170.8 dBm - Hz
Satellite Receiver bandwidth (25 kHz)	44.0 dB - Hz
Satellite Received Noise Power (N)	-126.8 dBm
<u>Carrier Budget</u>	
Ground Terminal EIRP (min.)	26.0 dBm
Freespace Path Loss (VHF Band)	167.0 dB
Satellite Antenna Gain (on axis)	47.0 dB
Service Contour	3.0 dB
Operating Margin	3.0 dB
Received Carrier Power (C)	-100.0 dBm
Uplink C/N	26.8 dB

TABLE B.4

TYPICAL DOWNLINK BUDGET

<u>Carrier Budget</u>	
Satellite EIRP (on axis)	59.2 dBm
Free Space Path Loss (VHF Band)	167.0 dB
Ground Antenna Gain	2.0 dB
Service Contour	3.0 dB
Operating Margin	3.0 dB
Received Carrier Power (C)	-111.8 dBm
<u>Noise Budget</u>	
Ground Terminal	
Receiver noise power density (T_s = 3000^{o}K)	-163.8 dBm - Hz
Receiver bandwidth (25 kHz)	44.0 dB - Hz
Received Noise Power (N)	-119.8 dBm
Downlink C/N	8 dB